Canadian Space Agency

2014–15

Departmental Performance Report

The Honourable Navdeep Bains, P.C., M.P.
Minister of Innovation, Science and Economic Development

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Ministers' Message

We are pleased to report on the Canadian Space Agency's key activities in 2014–15.

Our overarching goals within the Innovation, Science and Economic Development portfolio are to help Canadian businesses grow, innovate and export so that they can spur economic development and create good quality jobs and wealth for Canadians in all regions across the country; to help small businesses grow through trade and innovation; to promote increased tourism to Canada; to promote and support scientific research and the integration of scientific considerations in our investment and policy choices. We are committed to working closely with colleagues and stakeholders from all of these diverse fields to achieve these objectives.

We are pleased to present the 2014–15 Departmental Performance Report for the Canadian Space Agency.

The Honourable Navdeep Bains
Minister of Innovation, Science and Economic Development

The Honourable Kirsty Duncan
Minister of Science

The Honourable Bardish Chagger
Minister of Small Business and Tourism

Section I: Organizational Expenditure Overview

Organizational Profile

Minister of Innovation, Science and Economic Development:
The Honourable Navdeep Bains, P.C., M.P.

- The Honourable James Moore, P.C., M.P. (responsible Minister for 2014–15)

Minister of Science:
The Honourable Kirsty Duncan, P.C., M.P.

Minister of Small Business and Tourism:
The Honourable Bardish Chagger, P.C., M.P.

Institutional Head:
Sylvain Laporte, President

Ministerial Portfolio:
Industry (portfolio name for 2014–15)

Enabling Instrument(s):
Canadian Space Agency Act, S.C. 1990, c. 13

Year of Incorporation / Commencement:
Established in March 1989

The Canadian Space Agency was established in 1989. Approximately 90% of its employees are working at the headquarters located at the John H. Chapman Space Centre, in St-Hubert, Quebec. The remaining personnel serve the Agency at the Government Liaison Office and the David Florida Laboratory in Ottawa, with officials in Houston, Washington and Paris.

Organizational Context

Raison d'être

The objects of the Canadian Space Agency[1] (CSA) are *"to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians."*

The CSA is delivering on its mandate in collaboration with Canadian industry, academia, Government of Canada (GoC) organizations, and other international space agencies or organizations.

Responsibilities

The founding legislation that received Royal Assent in 1990 attributed four main functions to the CSA:

- Assist the Minister to coordinate the space policies and programs of the Government of Canada;
- Plan, direct, manage and implement programs and projects relating to scientific or industrial space research and development and the application of space technology;
- Promote the transfer and diffusion of space technology to and throughout Canadian industry; and
- Encourage commercial exploitation of space capabilities, technology, facilities and systems.

[1] To learn more about the mandate of the Canadian Space Agency, go to: http://www.asc-csa.gc.ca/eng/about/mission.asp

Strategic Outcome(s) and Program Alignment Architecture

1. Strategic Outcome: Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

- **1.1 Program:** Space Data, Information and Services
  - **1.1.1 Sub-Program:** Earth Orbit Satellite Missions and Technology
    - **1.1.1.1 Sub-Sub-Program:** Earth Observation Missions
    - **1.1.1.2 Sub-Sub-Program:** Communications Missions
    - **1.1.1.3 Sub-Sub-Program:** Scientific Missions
  - **1.1.2 Sub-Program:** Ground Infrastructure
    - **1.1.2.1 Sub-Sub-Program:** Satellite Operations
    - **1.1.2.2 Sub-Sub-Program:** Data Handling
  - **1.1.3 Sub-Program:** Space Data, Imagery and Services Utilization Development
    - **1.1.3.1 Sub-Sub-Program:** Earth Observation Data and Imagery Utilization
    - **1.1.3.2 Sub-Sub-Program:** Communications Services Utilization
    - **1.1.3.3 Sub-Sub-Program:** Scientific Data Utilization
- **1.2 Program:** Space Exploration
  - **1.2.1 Sub-Program:** International Space Station (ISS)
    - **1.2.1.1 Sub-Sub-Program:** International Space Station Assembly and Maintenance Operations
    - **1.2.1.2 Sub-Sub-Program:** International Space Station Utilization
  - **1.2.2 Sub-Program:** Exploration Missions and Technology
    - **1.2.2.1 Sub-Sub-Program:** Space Astronomy Missions
    - **1.2.2.2 Sub-Sub-Program:** Planetary Missions
    - **1.2.2.3 Sub-Sub-Program:** Advanced Exploration Technology Development
  - **1.2.3 Sub-Program:** Human Space Missions and Support
    - **1.2.3.1 Sub-Sub-Program:** Astronaut Training and Missions
    - **1.2.3.2 Sub-Sub-Program:** Operational Space Medicine
    - **1.2.3.3 Sub-Sub-Program:** Health and Life Sciences

1.3 Program: Future Canadian Space Capacity

1.3.1 Sub-Program: Space Expertise and Proficiency

1.3.2 Sub-Program: Space Innovation and Market Access

1.3.2.1 Sub-Sub-Program: International Market Access

1.3.2.2 Sub-Sub-Program: Enabling Technology Development

1.3.3 Sub-Program: Qualifying and Testing Services

1.4 Internal Services

Descriptions of Programs, Sub-Programs and Sub-Sub-Programs are in Section II.

Organizational Priorities

All CSA organizational priorities contribute to the strategic outcome. The CSA identified nine organizational priorities as presented in the 2014–15 Report on Plans and Priorities (RPP). Progress achieved in each of these priorities is reflected below.

Priority	Type	Program
Serve Canada's national interests of security (particularly in the Arctic), maritime surveillance, disaster management, ecosystem monitoring, sovereignty, and prosperity by furthering the development of the RCM[2] through the Canadian space industry. Ground stations located in the Canadian Arctic are required to take full advantage of the RCM and to receive data from various Canadian and foreign satellites.	Ongoing	1.1 Space data, information and services
Summary of Progress		
The CSA continued to implement the RADARSAT Constellation Mission (RCM) and develop the RCM Data Policy. Once in operation, the RCM will provide space information to respond to GoC needs for high-quality space data, applications and services essential to Canadians. It will also provide continuity and enhanced functionalities to RADARSAT-2. Satellite construction and infrastructure operation progressed as planned in 2014–15. Technical performance metrics indicate that the RCM will meet GoC needs and expectations in terms of quality, availability of service, schedule and authorized budget. The launch of the RCM remains scheduled for 2018. Finally, the CSA started to analyze and examine the need for an additional northeastern ground station in summer 2015.		

[2] RCM: RADARSAT Constellation Mission

Priority	Type	Program
Demonstrate innovative space-based solutions using key industrial capabilities to provide fast and cost-effective responses to government needs in specific areas such as safety and security, atmospheric and environmental monitoring, disaster management and satellite communication.	Ongoing	1.1 Space data, information and services

Summary of Progress

The focus of this priority is on developing mission concepts for Earth observation (EO) and satellite communications (SatComs), including the use of micro and small satellite platforms. The missions are aligned with the principles outlined in Canada's Space Policy Framework, which include putting Canadian interests first, promoting Canadian innovation by positioning the private sector at the forefront of space activities, paving the way forward in space, and ensuring that Canada remains a global leader in important areas of space technology and innovation.

According to letters of interest received from various GoC departments in 2013–14 and the input of user and science teams, which included eight GoC departments, five contracts were awarded to Canadian space firms in FY 2014–15 to undertake feasibility studies for mission concepts using a microsatellite platform.

The CSA awarded a contract to an industrial consortium to define a new Canadian Hyperspectral Mission (CHM). The mission is intended to provide weekly coverage of Canada with hyperspectral imagery at a resolution of 10 metres in support of several applications that have a far-reaching socioeconomic impact. A major goal of this undertaking is to identify a new approach to a hyperspectral sensor, enabling its use aboard a small spacecraft.

Priority	Type	Program
Establish a partnership with NASA[3] to participate in a demonstration mission for the global measurement of lake level and ocean circulation features to ultimately support Canada's need for hydrological and meteorological monitoring, ocean science, and forecasting while positioning sophisticated Canadian technology at the forefront of space activities.	Ongoing	1.1 Space data, information and services

Summary of Progress

Canada is contributing the Extended Interaction Klystron (EIK) instrument for the Surface Water and Ocean Topography (SWOT) mission, which is being developed primarily by NASA in collaboration with France's Centre national d'études spatiales. The main objective of the SWOT mission, which is scheduled for launch in 2020, is to regularly survey the globe for changes in the elevation and flow of the Earth's lakes, rivers and oceans. This international mission provides a strategic opportunity to put Canadian industry to use in areas of proven capabilities with high potential in leading-edge technologies.

During FY 2014–15, the development of the EIK was contracted to Canadian industry, and the first advanced prototype of the EIK was designed. A CSA-led team, including scientists from the Department of Fisheries and Oceans (DFO) and Environment Canada (EC), is ensuring that the technical and scientific work remains on track to adequately meet Canada's hydrological and oceanographic needs.

The data gathered by SWOT will enhance hydrological and oceanographic monitoring and forecasting services to Canadians, leading to improved information for floods, droughts, coastal tides and currents.

[3] NASA: National Aeronautics and Space Administration

Priority	Type	Program
Continue Canada's participation in the ISS by operating and upgrading the Canadian robotic elements (Canadarm2 and Dextre), performing scientific experiments and technology demonstrations, and creating flight opportunities for Canadian astronauts.	Ongoing	1.2 Space exploration
Summary of Progress		
Canada's ongoing participation in the International Space Station (ISS) directly contributed to Canada's Space Exploration Program by providing the means to demonstrate its technology in space, develop greater insight into how to operate systems for long-duration flights, improve operational procedures, and conduct life science research vital to future space exploration initiatives. In 2014–15, Canada continued to meet its obligations under the ISS Intergovernmental Agreement and supported all planned ISS missions using the Mobile Servicing System (MSS). It also extended its ability to operate this complex system in space and to identify future opportunities to demonstrate additional Canadian technologies on board the ISS. Furthermore, Canada continued to maximize its use of the ISS by Canadian science teams, particularly in the area of life sciences with high potential for benefits to human health. Through the ISS program, Canada continued toward its goal of better understanding and mitigating the health risks of long-term space travel. This priority is key to Canada's engagement in future space exploration missions beyond low Earth orbit.		

Priority	Type	Program
Foster the development of scientific instruments, advanced space robotics, optics and other technologies capable of contributing to future international space exploration missions.	Ongoing	1.2 Space exploration

Summary of Progress
In 2014–15, the CSA continued to contribute to long-term international space exploration missions, such as the James Webb Space Telescope (Webb), Japan's X-ray space observatory space telescope (ASTRO-H) and an asteroid sample return mission, the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx). Canada's contribution to these missions will expand Canada's key industrial capabilities and advance Canadian science. Furthermore, two partnership agreements were concluded between the CSA, universities and industry to prepare future international space exploration missions.

Priority	Type	Program
Generate, maintain and improve the conditions that support the development and retention of Highly Qualified Personnel (HQP) in space and related fields in order to meet Canada's future requirements for specialized expertise.	Ongoing	1.3 Future Canadian space capacity

Summary of Progress
In summer 2014, in collaboration with the French Centre national d'études spatiales, the first stratospheric scientific and technological balloons (Stratos) were launched in Timmins, Ontario. Seven balloons were flown over a six-week period, successfully launching a total of ten Canadian payloads. The Stratos launch campaign supported the creation and maintenance of 45 Canadian Highly Qualified Personnel (HQP) positions. The payloads produced valuable scientific and technical data that are now being analyzed. The memorandum of understanding between the CSA and the National Research Council was renewed, providing additional opportunities for HQP to prepare for upcoming space flights. Bilateral discussions were held with granting councils, Canadian industry and academia to facilitate knowledge and technology transfer promoting closer links between universities and industry in the priority areas of radar satellite, robotics, optics and satellite communications. Discussions aimed at potential collaboration with the newly established Consortium for Aerospace Research and Innovation in Canada were also initiated. Improvements to HQP in space-related fields were also possible as a result of bilateral discussions with granting councils, Canadian industry and academia.

Priority	Type	Program
Generate, maintain and improve the conditions that support innovation in space technologies that will meet future national needs and priorities.	Ongoing	1.3 Future Canadian space capacity
Summary of Progress		
A total of 38 new contribution agreements, valued at more than $13 million, with 21 companies across Canada were put in place to foster innovation, support the Canadian space sector's competitiveness and further develop Canadian space capabilities. Based on the experience gained and the lessons learned from the previous announcements of opportunity, the 2015–16 announcements of opportunity were prepared in order to sign the agreements and release the contributions as early as possible in the year. In December 2014, at a ministerial council meeting of the European Space Agency, Canada announced new investments of up to $5 million to allow Canadian space companies to further develop international collaboration and commercialization opportunities in Europe.		
Priority	**Type**	**Program**
Establish a new governance structure while strengthening corporate risk assessment and project management processes.	Ongoing	1.4 Internal services
Summary of Progress		
Reaching Higher: Canada's Interest and Future in Space (Volume 2) (2012), commonly referred to as the Emerson Report on Space, recommended improving stewardship, management and accountability. Implementing this recommendation has resulted in more robust external and internal governance of space activities, project management and priority setting. Interdepartmental space program integration boards at the assistant deputy minister and director general levels have been established to oversee the prioritization, sequencing, and program management of space asset development and utilization. The Deputy Minister Governance Committee for Space provides coordination and oversight to major space-related projects. Internal governance of the CSA has also been strengthened. Specifically, the CSA's new Integrated Investment Review Board, chaired by the CSA's President, was established to optimize resources and ensure excellence in the implementation, oversight and accountability of the CSA's five-year Investment Plan. This approach is strengthening investment prioritization while allowing for a larger perspective on		

risk and complexity assessment.

In November 2014, the government established an independent Space Advisory Board that reports to the Minister of Industry. The role of the Board, which includes experts from industry and academia, is to advise the Minister on Canada's space program. The CSA provides the Secretariat to the Board, which held its first meeting in February 2015.

Priority	Type	Program
Implement a five-year investment plan in accordance with TBS[4] policies.	Ongoing	1.4 Internal services

Summary of Progress

The Treasury Board of Canada approved the CSA's first five-year Investment Plan (IP) (2014–15 to 2018–19). During the development of the IP, the Investment Governance and Monitoring Framework was established and approved by the CSA's Executive Committee in April 2014. Since then, investment planning processes and procedures have been implemented accordingly. As part of the CSA's IP, the Integrated Investment Review Board, chaired by the CSA's President, was established in order to provide direction and oversight.

[4] TBS: Treasury Board Secretariat

Risk Analysis

Key Risks

Risks	Risk Response Strategy	Link to Program Alignment Architecture
Fiscal management The potential that costs may become greater than originally planned could reduce the amount of funds available to launch new initiatives. Increased costs could compel the CSA to reconsider priorities.	– Reduce technological uncertainty by implementing technology development activities at the design stage; – Assess projects' risks and allocate a financial risk margin based on the risks' impact and probability levels; – Monitor the implementation of a new CSA Project Management Policy; – Develop a new project management methodology; and – Where applicable, implement acquisition strategies based on risk sharing with industry partners.	1.1.1 Earth Orbit Satellite Missions and Technology 1.1.2 Ground Infrastructure 1.2.1 International Space Station (ISS) 1.2.2 Exploration Missions and Technology
Space capacity New international competitors, fluctuating technological development and the uncertainty associated with technological development may impact the long-term priorities of the CSA.	– Ongoing updating of the Canadian space technology requirements spectrum; – Promotion of partnerships between the private sector, the academic community and the CSA; – Ongoing monitoring of Canadian space sector conditions; and – Partnerships with foreign space agencies, expanding academia and industry opportunities to participate in the development of international missions.	1.1.3 Space Data Imagery and Services Utilization Development 1.2.2 Exploration Missions and Technology 1.3.1 Space Expertise and Proficiency 1.3.2 Space Innovation and Market Access

Risks	Risk Response Strategy	Link to Program Alignment Architecture
Gap between expectations and supply Due to possible schedule interruptions, infrastructure challenges, personnel availability, project implementation or changes in partners' requirements and priorities, there may be a gap between partners' expectations and the data and services provided by the CSA.	– Ongoing consultations with GoC departments and the academic community regarding long-term requirements; – Ongoing consultations during the development phase regarding operational requirements; – Cost-effectiveness analysis to determine whether small satellite development could provide fast and efficient space solutions; – Ongoing monitoring and implementation of mechanisms to optimize the allocation of RADARSAT-2 data portion of the GoC's credit; – Monitoring of space objects and collision-avoidance measures; and – Annual updating of the Integrated Human Resources Plan.	1.1.1 Earth Orbit Satellite Missions and Technology 1.1.2 Ground Infrastructure 1.2.1 International Space Station (ISS) 1.3.3 Qualifying and Testing Services
Financial resource management Because of costs, higher share of funding allocation to operations, or governance, targeted funding needs to be identified to meet CSA space requirements.	– Analysis of possible synergies between available resources and equipment, and new mission options; – Reassessment of operating costs; – Search for partnerships for operating cost sharing; – Continuous monitoring of project implementation; – Regular review of the project portfolio, activity plans and schedules; – Regular review of financial management strategies; and – Development of a guide for implementing and monitoring the investment planning policy.	1.1.1 Earth Orbit Satellite Missions and Technology 1.1.2 Ground Infrastructure 1.2.2 Exploration Missions and Technology 1.3.2 Space Innovation and Market Access

Risks Discussion

Helping Government of Canada organization deliver on their mandates

Space assets are increasingly used by GoC organizations to deliver their mandates. Since there is a large diversity of space missions and partnership opportunities to choose from in the current space economy, gaps may emerge between users' needs and services provided (i.e. risk of gaps between supply and demand). In 2014–15, the CSA continued to support the development of small satellite technology in order to provide fast and cost-effective response to users' needs, while continuing to support both Canadian industry and the academic community.

Furthermore, the CSA continued to manage and optimize RADARSAT-2 data allocation, ensuring that operational users' needs and requirements are met in a sustainable manner. This will complement data that will be made available as early as 2018, following the launch of the RADARSAT Constellation Mission. In addition, the CSA also implemented an interdepartmental governance model which helped identify and, in some cases, close the gaps between supply and demand. The model also provided oversight in terms of financial resources and performance of space activities.

Fostering a competitive Canadian space sector

The growth of small companies continues to represent a challenge in terms of their limited ability to market products and services worldwide. While the traditional approach of concentrating Canada's efforts in a few strategic technical fields has been successful to date, it has led to a highly concentrated industry. Consequently, the Canadian space sector, especially small and medium enterprises, remains reliant on continued research and development investments to overcome growth challenges. To mitigate the risk of insufficient capacity needed to address future national needs and priorities, the CSA continues to work with Canadian industry and academic leaders to identify ways in which the private sector can play a stronger leadership role in ensuring that the economic value of the GoC's space investments is fully realized (i.e. financial resource management risk). The CSA continues to advance space robotics and other key technologies, such as satellite communications, so as to maintain Canada's competitive edge.

In addition, the CSA developed sub-orbital platforms, such as the Stratos project, to step up the pace of highly qualified personnel training and innovation.

Finally, program and technical difficulties associated with space missions represent another major source of risk (i.e. space capacity risk). The international aspect of some projects can lead to additional challenges. These risks may lead to cost increases and scheduling issues (i.e. fiscal

management risk; financial resource management risk). In order to mitigate these risks, the CSA has implemented its new Investment Governance and Monitoring Framework, which enhances the management and control process already in place. In addition, the existing RCM Deputy Ministers' Committee was expanded, becoming the Deputy Minister Governance Committee for Space (DMGCS), to ensure a coordinated and focused approach to managing Canada's space program. Co-chaired by the Deputy Minister of Industry and the President of the CSA, the DMGCS has 13 participating departments/agencies.

Actual Expenditures

Budgetary Financial Resources (dollars)

2014–15 Main Estimates	2014–15 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	Difference (actual minus planned)
462,447,174	462,447,174	482,740,941	376,090,938	(86,356,236)

Any significant variance reported in relation to Planned Spending in the 2014–15 RPP is explained in Section II: Analysis of Program(s) by Strategic Outcome.

Human Resources (Full-Time Equivalents [FTEs])

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
643.6	592.9	(50.7)

Budgetary Performance Summary for Strategic Outcome(s) and Program(s) (dollars)

Strategic Outcome, Programs and Internal Services	2014–15 Main Estimates	2014–15 Planned Spending	2015–16 Planned Spending	2016–17 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	2013–14 Actual Spending (authorities used)	2012–13 Actual Spending (authorities used)
Strategic Outcome: Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.								
Space Data, Information and Services	256,908,528	256,908,528	259,609,001	174,805,520	264,953,284	175,496,334	207,544,469	130,830,203
Space Exploration	96,586,363	96,586,363	112,407,879	98,480,242	106,891,653	97,329,795	96,501,810	87,496,584
Future Canadian Space Capacity	62,772,518	62,772,518	66,268,193	66,630,064	63,376,550	58,018,955	55,453,614	52,480,907
Subtotal	416,267,409	416,267,409	438,285,073	339,915,826	435,221,487	330,845,084	359,499,893	270,807,694
Internal Services Subtotal	46,179,765	46,179,765	45,143,208	43,099,920	47,519,454	45,245,854	49,215,347	49,437,721
Total	462,447,174	462,447,174	483,428,281	383,015,746	482,740,941	376,090,938	408,715,240	320,245,415

Note: Due to rounding, amounts may not add up to totals shown

The changes in Expenditures since 2012–13 are mainly due to the following:

- $397 million allocated through Budget 2010 over five years (2010–11 to 2014–15) in order to develop the RADARSAT Constellation Mission (RCM) under the Space Data, Information and Services Program;
- An additional $374 million over six years (2013–14 to 2018–19) allocated for the RCM from the Fiscal Framework and Other Government Department transfers to the CSA;
- The cumulative impact of the reprofiling of funds associated with the sound management of high-risk projects and programs.

The 2014–15 total variance of $86.36 million between the Planned Spending and the Actual Spending is mainly due to the re-profiling of funds for the RCM under the Space Data, Information and Services Program in order to meet revised project milestones.

Alignment of Spending With the Whole-of-Government Framework

The Government of Canada (GoC) has adopted a Whole-of-Government Framework for reporting to Parliament on progress made as a nation. The WoG framework maps the financial and non-financial contributions of departments, agencies, and Crown corporations (http://www.tbs-sct.gc.ca/ppg-cpr/frame-cadre-eng.aspx). The Framework consists of four spending areas: Economic Affairs, Social Affairs, International Affairs, and Government Affairs. The CSA's programs can be linked to the following spending areas and GoC outcomes:

Alignment of 2014–15 Actual Spending With the Whole-of-Government Framework[i] (dollars)

Strategic Outcome: Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.			
Program	**Spending Area**	**Government of Canada Outcome**	**2014–15 Actual Spending**
1.1 Space Data, Information and Services	Government Affairs	Well-managed and efficient government operations	175,496,334
1.2 Space Exploration	Economic Affairs	An innovative and knowledge-based economy	97,329,795
1.3 Future Canadian Space Capacity	Economic Affairs	An innovative and knowledge-based economy	58,018,955

Total Spending by Spending Area (dollars)

Spending Area	**Total Planned Spending**	**Total Actual Spending**
Economic Affairs	159,358,881	155,348,750
Social Affairs	0	0
International Affairs	0	0
Government Affairs	256,908,528	175,496,334

Departmental Spending Trend

The CSA's annual A-Base budget of $300 million was initially established in Budget 1999 ($215.4 million in 2015 dollars), and is now of the order of $260 million. Significant factors reflected in the graph are:

- The re-profiling of funds resulting from sound management of high-risk projects and programs has had a beneficial cumulative impact (e.g. in terms of high technology risks, long-term development cycle, uncertainties with work schedules, implementation delays).

- Budget 2010 allocated $397 million to the CSA over five years (2010–11 to 2014–15) to develop the RCM. An additional $374.2 million over six years (2013–14 to 2018–19) was allocated for the RADARSAT Constellation Mission ($140.0 million of new funding from the Fiscal Framework and $234.2 million transferred from other GoC departments to the CSA).

- On August 4, 2011, an Order in Council established Shared Services Canada (SSC) as part of the Public Works and Government Services Canada (PWGSC) portfolio to streamline and reduce duplication in the government's information technology services.

SSC consolidates resources and personnel currently supporting email, data centres and networks, and associated internal services. In 2011–12, unexpended authorities related to functions transferred to SSC corresponded to $3.5 million. Thus, at the beginning of fiscal year (FY) 2012–13, the CSA transferred $7.2 million to SSC.

- The CSA's contribution to the Budget 2012 Strategic Operating Review was $7.9 million for FY 2012–13, $24.7 million for FY 2013–14 and $29.5 million for FY 2014–15.

- Additional funding and expenditure authority on the order of $12.0 million was authorized during FY 2014–15 for two years (FY 2014–15 and 2015–16) in order to provide enhanced space-based Automatic Identification System data services.

Estimates by Vote

For information on the CSA's organizational votes and statutory expenditures, consult the *Public Accounts of Canada 2015*,[ii] available on the Public Works and Government Services Canada website.[iii]

Section II: Analysis of Program(s) by Strategic Outcome

Strategic Outcome:

Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

Program 1.1: Space Data, Information and Services

Description

This Program includes the provision of space-based solutions (data, information and services) and the progression of their utilization. It also serves to install and run ground infrastructure that processes the data and operates satellites. This Program utilizes space-based solutions to assist Government of Canada (GoC) organizations in delivering growing, diversified or cost-effective programs and services within their mandate which is related to key national priorities, such as sovereignty, defence, safety and security, resource management, environmental monitoring and the North. It also provides academia with data required to perform its own research. The services delivered through this Program are rendered, and the data and information are generated and processed, with the participation of the Canadian space industry, academia, GoC organizations, national and international organizations, such as: foreign space agencies, not-for-profit organizations, as well as provincial and municipal governments. This collaborative effort is formalized under national and international partnership agreements, contracts. This Program is also funded through the Class Grant and Contribution Program.

Budgetary Financial Resources (dollars)

2014–15 Main Estimates	2014–15 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	2014–15 Difference (actual minus planned)
256,908,528	256,908,528	264,953,284	175,496,334	(81,412,194)*

Human Resources (Full-Time Equivalents [FTEs])

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
109.8	103.8	(6.0)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. GoC organizations offer more diversified or cost-effective programs and services due to their utilization of space-based solutions.	1. Number of new GoC programs offering more diversified or efficient services.	Target was not yet established**	36 programs

Performance Analysis and Lessons Learned

This indicator is used to determine the growing impact of space-based solutions on the effectiveness of government programs and services. Enumerating GoC programs benefiting from Earth observation applications and other satellite services provides an important indicator for measuring the success of the CSA's programs. For the first time in 2014–15, GoC departments were formally asked to identify which of their programs benefit from space-based solutions. Among the 14 departments surveyed, a total of 36 programs were identified. For example, Agriculture and Agri-Food Canada uses space-based data to support its Mapping Invasive Impacts program, Environment Canada uses space-based data for its marine pollution and meteorological and ice services in support of Marine Navigation programs, and the Canadian Forest Service uses space-based data for its Forest Disturbance Sciences and Applications program. This year's results are attributable to over a decade of investments in EO capacity building.

*As noted in the Budgetary Financial Resources table, the variance explanation can be found in Sub-Sub-Program 1.1.1.1.

**The CSA first introduced this indicator in the 2013–14 Report on Plans and Priorities (RPP) but was unable to establish an accurate target as planned in that RPP. Therefore, the 2014–15 results provide the benchmark that will be used for future planning and performance reports.

Sub-Program 1.1.1: Earth Orbit Satellite Missions and Technology

Description

This Sub-Program encompasses the development of complete Canadian satellite systems or of sub-systems, payloads, instruments or other components provided to domestic and foreign satellites. This Sub-Program also includes the development of advanced technologies that could shape or determine the nature of potential new Earth orbit satellite missions. This Sub-Program is necessary because Government of Canada (GoC) organizations use satellite-generated data, information and services to deliver their mandate; and so do academia to perform their research. This Sub-Program is delivered in collaboration with GoC organizations, along with the participation of Canadian industry, academia and foreign space agencies. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
233,703,298	147,076,358	(86,626,940)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
72.5	68.3	(4.2)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. GoC organizations are using space-based data to deliver their mandate.	1. Number of GoC programs using space data or services to deliver their mandate.	Target was not yet established**	36 programs
	2. Percentage of RADARSAT data used in program's delivery.	40% Research and Development 60% Operational	37% Research and Development 63% Operational

Performance Analysis and Lessons Learned

Information collected from 14 GoC departments indicates that 36 of their programs are using space data or services to deliver their mandate. These GoC programs are mainly using RADARSAT data (from RADARSAT-2), while some programs are using data from other space missions. Automatic Identification System data was used by 11 GoC departments and 12 of their programs. One program used SCISAT-1, the Canadian satellite focusing on polar ozone status and dynamics, and two programs used data from the Soil Moisture and Ocean Salinity mission. As mentioned in Program level 1.1, 2014–15 was the first year that the CSA formally surveyed GoC departments. Efforts will continue to be made with respect to the data collection methodology for this indicator in order to obtain more detailed and accurate information for future reports.

Moreover, it was determined that 63% of total RADARSAT data consumed was used for operational purposes by GoC programs, while 37% was used for research and development (R&D) purposes. Given the results reported in the 2013–14 DPR, the established targets of 60% for operational purposes and 40% for R&D were based on two key CSA initiatives. First is the Earth Observation Application Development program, which supports projects that use large quantities of data for R&D purposes. Second, the CSA implemented the Enhanced Marine Order Coordination working group to coordinate data acquisition within the GoC. This working group has been effective in managing operational data allocation and simultaneous needs among GoC departments, and has led to improved access to data for R&D purposes.

**The CSA first introduced this indicator in the 2013–14 Report on Plans and Priorities (RPP) but was unable to establish an accurate target as planned in that RPP. Therefore, the 2014–15 results provide the benchmark that will be used for future planning and performance reports.

Sub-Sub-Program 1.1.1.1: Earth Observation Missions

Description

This Sub-Sub-Program encompasses the definition, design, technology development, and implementation of Earth orbit satellites dedicated to producing data, information or imagery of Earth and its atmosphere, ranging from its subsurface to its upper atmospheric layers, including space surveillance for asteroids, Earth orbiting objects and space debris. This Sub-Sub-Program serves continuous operations and is necessary to produce pertinent Earth Observation data and imagery that assist with the mandate delivery of Government of Canada (GoC) organizations that deal especially with key national priorities, such as environment, climate change, weather, natural resources, sovereignty, defence, safety and security. It also provides academia with data required for its research. This Sub-Sub-Program is delivered in collaboration with GoC organizations, along with the participation of Canadian industry, academia and foreign space agencies. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
226,966,923	139,373,747	(87,593,176)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
54.5	56.0	1.5

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Earth observation missions provide GoC organizations and academia with data and information.	1. Number of GoC programs provided with data and images from EO missions.	Target was not yet established**	36
	2. Number of users of EO data.	Target was not yet established**	81
	3. Number of academia provided with data and images from Earth observation missions.	10	16

Performance Analysis and Lessons Learned

In 2014–15, GoC departments and agencies as well as the scientific community continued to be supplied with RADARSAT-2 data and information.

As reported earlier, a total of 36 GoC programs used space-based Earth observation solutions, mainly from the RADARSAT-2 mission. The information was collected by the CSA using a survey methodology. Most of the programs identified have benefited from the CSA's Government Related Initiatives program (GRIP). This program supports the development of GoC capacity to use EO data, especially RADARSAT-2 data. Its purpose is also to accelerate the integration of data into departmental operations and promote the development of new innovative space-based solutions in support of departmental mandates.

At the time this departmental performance report was written, there were 313 users from both federal and provincial governments authorized to order RADARSAT-2 data. In 2014–15, 81 of them ordered RADARSAT-2 solutions. Out of the approximately 26,000 scenes consumed per year, 78% is used by three departments: Environment Canada, Department of National Defence and Natural Resources Canada.

In 2014–15, 16 Canadian universities used data and images from the RADARSAT-2 mission, made available through the Science and Operational Applications Research (SOAR) initiative.

*As noted in the Budgetary Financial Resources table, the significant variance of $87 million is largely attributable to the re-profiling of funds for the RADARSAT Constellation Mission. Those funds will be used at a later time in order to meet revised project milestones.

**The CSA first introduced this indicator in the 2013–14 Report on Plans and Priorities (RPP) but was unable to establish an accurate target as planned in that RPP. Therefore, the 2014–15 results provide the benchmark that will be used for future planning and performance reports.

Sub-Sub-Program 1.1.1.2: Communications Missions

Description

This Sub-Sub-Program encompasses the definition, design, technology development, and implementation of Earth orbit satellites dedicated to delivering continuous communications, including Navigation, Positioning and Timing (NPT) services. This Sub-Sub-Program serves continuous operations and is necessary to provide pertinent communications and NPT services that assist Government of Canada (GoC) organizations in the delivery of their mandate, particularly those locating and monitoring vehicle or ship signals, those dealing with remote communities or those managing other key national priorities, such as sovereignty, defence, safety and security. This Sub-Sub-Program is delivered in collaboration with GoC organizations, along with the participation of Canadian industry, academia and foreign space agencies. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
2,325,450	5,452,942	3,127,492*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
14.5	9.3	(5.2)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Satellites provide communications services that respond to the expressed needs of GoC organizations	1. Number of satellite communication missions/instruments in operation.	2	1
	2. Number of GoC organizations using data from satellite communication missions.	1	1

Performance Analysis and Lessons Learned

The Cascade, Smallsat Bus and Ionospheric Polar Explorer (CASSIOPE) mission, carrying the enhanced Polar Outflow Probe, or ePOP, was launched in September 2013 and was fully commissioned in November 2013. In 2014–15, the design, development and manufacture of the satellite contributed to Canadian industry's capability to build small satellite buses and space-based systems able to handle large volumes of data at high transmission rates. The satellite has exceeded its expected design life cycle of two years.

The launch of the Maritime Monitoring and Messaging Microsatellite (M3MSat), previously planned for 2014, has been delayed to April 2016 for geopolitical reasons. As a result, the performance for this first indicator is lower than planned, with only one satellite in operation instead of two. The spacecraft and the ground segment have both been built as planned and are currently in storage awaiting launch. The purpose of this project, conducted jointly by the CSA and the Department of National Defence, is to demonstrate the usefulness of an advanced space-based Automatic Identification System. M3MSat, once launched, can be used for operational purposes as a sensor source to be included in the Recognized Maritime Picture. This contributes to maritime domain awareness, an essential component of Canada's security and safety.

*As noted in the Budgetary Financial Resources table, the variance of $3 million is mainly due to an internal budget reallocation of $2.2 million for the delayed launch of M3MSat.

Sub-Sub-Program 1.1.1.3: Scientific Missions

Description

This Sub-Sub-Program encompasses the definition, design, technology development, and implementation of Earth orbit satellites dedicated to producing scientific data and information for research performed by Government of Canada (GoC) organizations or academia. Examples of this research are those pertaining to climate processes and space weather (solar winds and their interaction with the Earth's magnetic field). This Sub-Sub-Program is necessary to produce pertinent scientific data and information that allow GoC organizations to mitigate damage or avoid the disabling of critical ground and space infrastructure, such as pipelines, electricity networks and satellites that can sustain damage from the effects of solar winds. In addition, with their enhanced understanding of climate processes and the improved models made possible through this Sub-Sub-Program, GoC organizations are better able to provide weather and climate forecasting. Academia also uses the data and information produced through this Sub-Sub-Program to perform its own research. This Sub-Sub-Program is delivered in collaboration with GoC organizations, along with the participation of Canadian industry, academia and foreign space agencies. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
4,410,925	2,249,669	(2,161,256)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
3.5	3.0	(0.5)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Sun-Earth System Science missions reflect GoC organizations and academia priorities	1. Number of Sun-Earth System missions / instruments in operation.	25	28
	2. Number of Canadian and international partners participating in the CSA's Sun-Earth System Science missions.	130	178

Performance Analysis and Lessons Learned

In 2014–15, a total of 28 Sun-Earth System Science (SESS) missions and instruments were in operation. These SESS missions/instruments include the Fourier Transform Spectrometer (FTS) and Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) instruments on the CSA's SCISAT-1, the NASA/CSA CloudSat mission, the Canadian Electric Field Instruments on each of the European Space Agency (ESA)'s three Swarm satellites, the Optical Spectrograph and Infra-Red Imaging System (OSIRIS) instrument on Sweden's Odin satellite, the Measurements of Pollution in the Troposphere (MOPITT) instrument on NASA's Aura satellite, and the eight instruments of the enhanced Polar Outflow Probe (ePOP) payload on CASSIOPE. Also included are the magnetometer and all-sky imager (ASI) networks for NASA's Time History of Events and Macroscale Interactions during Substorms (THEMIS) mission, and the ten instrument networks of the CSA's geospatial observatory (GO Canada).

Of these satellites, the Canadian satellite SCISAT-1 is the only mission that provides high vertical resolution data on many of the chemical species (i.e. gases) present in the atmosphere, including greenhouse gases. The MOPITT (1999), OSIRIS (2001) and SCISAT-1 (2003) instruments have all greatly exceeded their expected design lives and continue to provide data of the highest quality, supporting the generation of an ever-increasing number of scientific publications and hundreds of users around the world.

Since September 29, 2013, the ePOP payload on the CASSIOPE spacecraft continues to contribute to the study of space weather. The suite of eight scientific instruments collects data on solar storms, more specifically the storms' harmful effects on radio communications, satellite navigation, and other space and terrestrial systems.

Since November 2013, the three Swarm mission satellites, launched by ESA, have been carrying a full range of new generation instruments developed with European and Canadian technological expertise. These instruments gather highly accurate data that expand our knowledge of the

Earth's magnetic field. One of them, the Canadian Electrical Field Instrument (EFI), collects information about the conditions in the Earth's ionosphere that scientists use to analyze their effects on space-based and ground infrastructure (e.g. on radio communications, satellite navigation and other space and terrestrial systems). With the CSA's financial support, researchers from the University of Calgary contributed in the design of the Thermal Ion Imagers for the EFI instruments.

According to a voluntary annual survey, 178 Canadian and international institutions participated in Sun-Earth System Science activities (e.g. instrument development and operation, use of data products, modeling and analysis). This number not only exceeds the target of 130 but is also greater than the 143 organizations reported last year.

*As noted in the Budgetary Financial Resources table, the variance of $2 million is mainly due to revised cash flow requirements for delays in the contract issuance for the Surface Water and Ocean Topography (SWOT) satellite project.

Sub-Program 1.1.2: Ground Infrastructure

Description

This Sub-Program includes the development, installation and use of an integrated and coordinated national system of ground infrastructure to receive data from domestic or foreign satellites. In addition, the ground infrastructure houses and uses the equipment required for satellite operations. This Sub-Program is necessary to operate satellites as well as to process and make available space-based data received by the Canadian Space Agency to assist Government of Canada (GoC) organizations in delivering their mandate. Finally, this Sub-Program capitalizes on Canada's geographical advantage by capturing space data from the increasing number of satellites flying over the Arctic and by installing ground stations in this strategic location. This Sub-Program is delivered with the participation of industry, GoC organizations and foreign space agencies. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
12,931,520	13,768,848	837,328

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
28.9	27.8	(1.1)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Expressed Canadian and foreign data needs are fulfilled by ground infrastructure.	1. Percentage of acquisition requests fulfilled.	RADARSAT-2 85% SCISAT-1 85% NEOSSat 70%	RADARSAT-2 84% SCISAT-1 98% NEOSSat N/A
	2. Ratio of acquisition requests fulfilled to mission's acquisition requirements.	RADARSAT-2 50% SCISAT-1 80% NEOSSat 65%	RADARSAT-2 84% SCISAT-1 99% NEOSSat N/A
2. National ground infrastructure is reliable.	1. Percentage of successful satellite contacts.	90%	95%

Performance Analysis and Lessons Learned

Ground infrastructure performance depends on two main factors:

- The availability of a skilled and highly qualified workforce and a combination of public and private sector organizations involved in satellite operations in order to maintain high operating standards; and
- The robustness and reliability of ground infrastructure. Maintenance and modernization of infrastructure must be carefully planned in order to accommodate the growing requirements related to satellite data.

The high level of reliability of RADARSAT-2 and SCISAT-1 shows that such high performance is possible.

In 2014–15, RADARSAT-2 was able to fulfill 84% of the acquisition requests, significantly higher than the 75% reported in 2013–14. Resource constraints and commercial conflicts were the main reasons for unfulfilled requests. A whole-of-government (WoG) approach to deconflict requests was adopted and a new mechanism was implemented in March 2014 so as to optimize the use of satellite and ground resources.

The SCISAT-1 Sun-Earth System satellite, which focuses on polar ozone budget and dynamics, and is designed for a two-year lifespan, continues to outperform after 11 years of operation. The percentage of acquisitions fulfilled (98%) is beyond expectations (85%), leading to high capacity for meeting user requirements (99%). The skills needed to mitigate system anomalies remain an essential factor in ensuring a high level of performance.

On the other hand, the Near-Earth Object Surveillance Satellite (NEOSSat) reached initial operating capability in February 2015. Throughout the year, the flight operation and science teams worked together to improve system robustness and achieve final operating capability. The delay in reaching operating capability caused the number of successful observations to be too low to be statistically significant to be used to determine an accurate percentage of system availability for 2014–15.

Sub-Sub-Program 1.1.2.1: Satellite Operations

Description

This Sub-Sub-Program encompasses the Telemetry, Tracking and Command (TT&C) of Canadian satellites or of foreign satellites when such services are required from Canadian stations. It also includes the development, installation and use of ground infrastructure that processes the data and operates satellites. This Sub-Sub-Program is necessary to render orbiting satellites functional. The operations of Canadian Space Agency (CSA) satellites are mostly conducted with CSA equipment located in Canada. In some instances, formal arrangements can be concluded between CSA, Canadian industry, Government of Canada (GoC) organizations or international partners to operate one party's satellites using another party's equipment. Those arrangements can also provide for the location of one party's equipment in another party's facilities.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
7,227,840	7,987,798	759,958

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
26.6	24.3	(2.3)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. The CSA's satellites are functioning as per operational requirements.	1. Percentage of system availability.	SCISAT-1: 90% NEOSSat: 80%	SCISAT-1: 99.34% NEOSSat: N/A*
	2. Number of Canadian satellites operated by the CSA as per operations requirements.	2: SCISAT-1 and NEOSSat	2
2. Foreign satellite missions are supported.	1. Number of foreign satellites supported.	2	6

Performance Analysis and Lessons Learned

The percentage of system availability of the SCISAT-1 satellite continued to exceed expectations. October 2014 marked its 11th year of operation. The data produced by SCISAT-1, the only satellite that provides vertical resolution data on many chemical species (i.e. various gases) in the atmosphere, are used in climate studies and to monitor weather and pollution conditions in the polar zone, including greenhouse gases. The SCISAT-1 data help scientists assess the atmosphere's response to natural and human-caused changes while improving climate and weather models. While SCISAT's extended operating life continues to be supported by the CSA's operating budget, an external review conducted in 2013 concluded that the scientific impacts of the mission were well above the average in the field and called for a strategic review with partners and stakeholders. In June 2014, the findings of the strategic review resulted in a decision to extend SCISAT's operations and data analysis.

*In the meantime, NEOSSat, launched in February 2013, has been carrying out the High Earth Orbit Surveillance System science plan. Additional work is being conducted to refine spacecraft performance in order to also accomplish the Near Earth Space Surveillance mission.

System availability requires constant monitoring. The CSA safeguards its satellites in orbit in a continuous manner, by taking operational actions as required to protect against space debris. In addition, the CSA works with the Department of National Defence and consults with foreign agencies to ensure the latest tools and information are available to protect any satellites from the impact of potential debris in space. The CSA continues to participate in international forums concerning space debris while sharing its operational expertise in avoiding space debris with the use of other Canadian satellite operators.

For over a decade, the CSA has been part of an engagement strategy with international partners involving the exchange of operational services. In 2014–15, the CSA worked with the German Aerospace Center (DLR) on three international satellites: TerraSAR-X, TanDEM-X and TET, and with NASA on Grace 1 and 2 and CALIPSO.

Sub-Sub-Program 1.1.2.2: Data Handling

Description

This Sub-Sub-Program includes a coordinated national approach to determine optimal station locations and space data handling. This Sub-Sub-Program is necessary for the planning and tasking of data acquisition, as well as the capture, calibration, cataloguing, archiving and availability of space data received from domestic or foreign satellites to assist Government of Canada (GoC) organizations in delivering their mandate. Data handling operations are mostly conducted with Canadian Space Agency (CSA) equipment, located in its ground facilities. In some instances, formal arrangements can be concluded between CSA, GoC organizations or international partners to use another party's equipment located within its facilities. This Sub-Sub-Program is delivered with the participation of Canadian industry, foreign space agencies and GoC organizations. This collaborative effort is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
5,703,680	5,781,050	77,370

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
2.3	3.5	1.2

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Satellite data provided to GoC organizations and academia.	1. Number of RADARSAT-2 frames delivered to GoC organizations and other customers.	25,000 frames	29,365 frames
	2. Number of reliable and used instruments in Sun-Earth System Science.	28	28

Performance Analysis and Lessons Learned

In 2014–15, RADARSAT-1 and RADARSAT-2 data consumption was very close to the ceiling of 30,000 scenes (29,365). As a result of past trend analyses, the CSA negotiated for a greater number of scenes for 2014–15 as it forecasted an increased demand for RADARSAT-1 and RADARSAT-2 data. The ceiling was successfully increased from 30,000 scenes (ceiling for FY 2013–14) to 33,000 scenes (ceiling for FY 2014–15), thus preventing higher processing fees for data over the ceiling negotiated initially. This negotiation was part of an annual amendment to the RADARSAT-2 master agreement for volume of data to be processed in a given fiscal year.

Even though RADARSAT-1 ceased functioning on March 29, 2013, the CSA continued to provide archived satellite imagery to user communities. Recognizing that RADARSAT-1 is complementary to RADARSAT-2, the CSA is weighing the option of enhancing the use of RADARSAT-1 and possibly RADARSAT-2 archived data in line with GoC's Open Data Policy. Measures are currently in place to optimize the use of RADARSAT-2 data allocation until the RADARSAT Constellation Mission is launched in 2018. In addition, a whole-of-government (WoG) approach and other enhancements with respect to the handling of data orders were adopted in 2014–15, resulting in a more efficient use of credits and a significant reduction in data acquisition conflicts between GoC users.

The CSA continues to actively participate in the International Charter on Space and Major Disasters by providing Earth observation data, mostly from RADARSAT-2. Data provided as part of the Charter's activation helped minimize the impact of disasters on human lives and property. In 2014–15, the International Charter was activated 41 times.

Under the leadership of the intergovernmental Group on Earth Observations, the CSA continued to support the implementation of key international initiatives, such as the Joint Experiment for Crop Assessment and Monitoring, to monitor crops from space; the Space Data Coordination Group, to monitor forest carbon; the Global Forest Observations Initiative; and the Committee on Earth Observation Satellites, a working group on disasters.

As mentioned under Sub-Sub-Program (SSP) 1.1.1.3, Scientific Mission, the number of reliable and used instruments in Sun-Earth System Science met the projection with an array of 28 instruments. For a detailed listing, refer to SSP 1.1.1.3 below.

Sub-Program 1.1.3: Space Data, Imagery and Services Utilization Development

Description

This Sub-Program develops utilization of space-based data, imagery and information, and of communications services available on space assets for the benefit of the user community, primarily Government of Canada (GoC) organizations and academia. This Sub-Program is necessary to foster the development of a Canadian value-added industry that turns space data and information into readily useable products, as well as to increase the ability of GoC organizations to use space-based solutions (data, information and services) for the delivery of their mandate and to increase the ability of academia to perform their research. This Sub-Program engages the participation of the Canadian space industry and academia and is formalized under contracts and partnership agreements with national, public/private and international organizations. This Sub-Program is also funded through the Class Grant and Contribution Program.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
10,273,710	14,651,128	4,377,418*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
8.3	7.7	(0.6)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. GoC organizations are using space-based solutions to deliver their mandate.	1. Number of GoC programs using developed applications and related information.	Target was not yet established**	11 programs
	2. Average number of programs using each developed application.	Target was not yet established**	4 programs
2. The Canadian scientific community uses space-based data to conduct their research.	1. Number of peer-reviewed papers related to data utilization produced in academia and R&D community in Canada.	SOAR: 7 SESS: 200	SOAR: 0 SESS: 253

Performance Analysis and Lessons Learned

To help other government departments and agencies improve efficiency by using space-based solutions, the CSA invests in external resources such as contractors and university research teams to support the development of applications that bridge the gap between space data and government services.

These performance indicators measure the success of the CSA's programs by listing the number of GoC programs which use applications that became fully operational during a 12-month period due to the CSA's funding and support. The GoC programs must demonstrate that the applications developed using data generated by space missions have been successfully integrated into their operations. It should be noted that it may take more than five years for an application to reach a successful operational level. On average, an operational application is used by four different GoC programs.

As mentioned in Program level 1.1, 2014–15 was the first year the CSA formally surveyed GoC departments. Each year, the data collection methodology for this indicator will be improved on an ongoing basis in order to obtain more detailed and accurate information for future reports.

In 2014–15, a total of 14 departments were surveyed. They identified 11 programs that used RADARSAT's many capabilities which allowed them to invest in new long-term capabilities to better fulfill their mandates. The Department of National Defence's Polar Epsilon Project has become one of the biggest users of Canadian Synthetic Aperture Radar (SAR) data, along with Environment Canada's (EC's) Ice Service. Other examples include EC's Integrated Satellite Tracking of Pollution (ISTOP) program, which uses satellite imagery to monitor pollution in coastal waters; the SARWind project, a joint project with industry that allows EC's

Meteorological Service to improve the analysis of winds and short-term forecasts in large marine areas, especially in coastal areas; the ecological monitoring of national parks by Parks Canada; the mapping of northern regions by Natural Resources Canada; annual crop monitoring by Agriculture and Agri-Food Canada; and flood mapping by Public Safety Canada.

The Science and Operational Applications Research (SOAR) initiative aims to increase the use of space data in scientific research. Even though data collection for this report did not include peer-reviewed papers published—hence the figure of 0 peer-reviewed papers reported in 2014–15—there were 12 research and development proposals from Canadian organizations evaluated in 2014–15: 11 proposals from academia and one from a Canadian territory.

It was a productive scientific year in terms of data collected for Sun-Earth System Science activities; a total of 253 peer-reviewed publications acknowledged support from the CSA. By field, there were 134 publications in solar-terrestrial sciences, 96 in atmospheric sciences and 23 in Earth system science.

*As noted in the Budgetary Financial Resources table, the variance explanation can be found in Sub-Sub-Program 1.1.3.2.

**The CSA first introduced this indicator in the 2013–14 Report on Plans and Priorities (RPP) but was unable to establish an accurate target as planned in that RPP. Therefore, the 2014–15 results provide the benchmark that will be used for future planning and performance reports.

Sub-Sub-Program 1.1.3.1: Earth Observation Data and Imagery Utilization

Description

This Sub-Sub-Program develops the utilization of Earth observation (EO) imagery and atmospheric data acquired from Canadian and foreign space assets, ranging from its sub-surface to its upper atmospheric layers. This also applies to weather and climate imagery. This Sub-Sub-Program is necessary to broaden the applicability of currently available Earth observation space products and services (optimization) or to create new ones (innovation) for the user community (Government of Canada [GoC] organizations and academia). This Sub-Sub-Program engages the participation of the Canadian space industry and academia and is formalized under contracts and partnership agreements with national, public/private and international organizations. This Sub-Sub-Program is also funded through the Class Grant and Contribution Program.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
9,770,510	10,202,030	431,520*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
7.2	6.7	(0.5)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Enhanced GoC organizations ability to turn space data into products and services.	1. Number of EO data utilization activities supporting the development and utilization of data.	GRIP:[5] 10	21
2. Canadian industry ability to turn space data into products and services.	1. Number of EO data utilization activities supporting the development and utilization of data.	EOADP:[6] 24	31
3. The scientific community produces new ideas to turn space data into products and services.	1. Number of EO data utilization activities supporting the development and utilization of data.	SOAR:[7] 175	233

Performance Analysis and Lessons Learned

There are three distinct yet complementary communities benefiting from the development of the CSA's Earth observation applications namely, GoC departments, the private sector and academia.

In 2014–15, there were a total of 21 Government Related Initiatives program (GRIP) activities. These activities included 19 ongoing partnerships with GoC departments, two of which were

[5] GRIP: Government Related Initiatives program

[6] EOADP: Earth Observation Application Development program

[7] SOAR: Science and Operational Applications Research for RADARSAT-2

conducted to raise awareness and demonstrate the capability of Earth observation (EO) to meet the GoC's mandate and priorities. One partnership involved the CSA providing support in February 2015 to the Government of Alberta for a workshop focusing on the use of EO technology for more effective regulation of resource development and decision making. The second was a partnership in which the CSA and ESA held a workshop in Ottawa entitled "Arctic and High-Latitude Products Evolution and Validation." One objective was to foster the development and improvement of a broad spectrum of capabilities offered by space-based EO technology in response to the Arctic information needs of the GoC and national and international stakeholders.

Also noteworthy is the RADARSAT Constellation Mission (RCM). This project has developed a Data Utilization Application Plan (DUAP) and includes investing $12 million in the development of applications by GoC departments to facilitate the integration of RCM Synthetic Aperture Radar data into existing applications and/or operational needs. A total of 13 activities under the DUAP were supported in 2014–15.

There are 31 industry-led innovative space-based application activities as part of the Earth Observation Application Development program (EOADP). There were a total of 21 initiated in 2014–15, 12 of which addressed an environmental issue. Acting on the recommendation of the application program evaluation, nine projects were funded through the CSA's Grant and Contribution Program. In addition, the EOADP has also successfully issued a joint announcement of opportunity with the German Aerospace Center (DLR) to optimize research and development and foster synergy between the two countries.

There were a total of 233 SOAR projects in 2014–15, 125 of which were newly implemented during the period covered by this report. These projects included various national and international activities that also addressed provincial and territorial issues (SOAR Education, SOAR Africa, SOAR JECAM, SOAR Education International, SOAR Province, SOAR ASI, SOAR EU, SOAR Geohazard). Responses to joint SOAR activities with the Italian Space Agency (ASI), including one with the European Union, exceeded partners' expectations; there were 125 proposals, which led to 89 new initiatives. Overall, more than 3,000 SAR data scenes were provided to the scientific community in 2014–15.

*As noted in the Budgetary Financial Resources table, increased funding of this Sub-Sub-Program enhanced the number of projects supported.

Sub-Sub-Program 1.1.3.2: Communications Services Utilization

Description

This Sub-Sub-Program develops the utilization of space communications, including Navigation, Positioning and Timing (NPT) services available through Canadian and foreign satellites. This Sub-Sub-Program is necessary to broaden the applicability of currently available communications services (optimization) or to create new ones (innovation) for Government of Canada (GoC) organizations. This Sub-Sub-Program engages the participation of the Canadian space industry and is formalized under contracts, grants, contributions and partnership agreements with national, public/private and international organizations.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
329,900	4,443,959	4,114,059*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
1.0	1.0	0.0

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Enhanced GoC organizations ability to use communications space assets.	1. Number of communications application development activities supporting the development and utilization of services.	4	0

Performance Analysis and Lessons Learned

Over the past three years, GoC departments have significantly increased their use of telecommunications data, particularly Space-based Automatic Identification System (S-AIS) data. According to internal tracking documents, the average volume of data in gigabytes per month has increased by 350% since July 2012. Currently, 11 GoC departments use S-AIS data, and the number of users within each department is growing as well. This has created the need to invest in the development of applications in order to maximize the efficiency of S-AIS data. The target of four was based on S-AIS application development activities completed in previous

years. In 2014–15, the CSA put on hold application development activities to assess the current state-of-the-art usage of S-AIS data within the GoC user community to identify needs, gaps and level of interest in S-AIS technologies and data. The information gathered will be taken into consideration for future investment in the development of AIS applications.

*As noted in the Budgetary Financial Resources table, the variance of $4 million is mainly due to additional funding received in order to provide enhanced S-AIS data services.

Sub-Sub-Program 1.1.3.3: Scientific Data Utilization

Description

This Sub-Sub-Program develops the utilization and validates the quality of Canadian and foreign space-based scientific data and derived information that address science questions, such as those related to our understanding of the Earth's climate system and magnetic field (magnetosphere). This Sub-Sub-Program involves the collaboration of Canadian scientists from Government of Canada (GoC) organizations and academia. This Sub-Sub-Program is necessary to broaden the applicability of currently available space scientific data (optimization) or to create new ones (innovation) for GoC organizations and academia, especially in weather forecasts, climate change and space weather. This Sub-Sub-Program engages the participation of the Canadian space industry, academia and GoC organizations scientists, and is formalized under contracts and partnership agreements with national, public/private and international organizations. This Sub-Sub-Program is also funded through the Class Grant and Contribution Program.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
173,300	5,139	(168,161)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
0.2	0.0	(0.2)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Enhanced scientific community ability to use scientific data.	1. Number of Sun-Earth System Science activities supporting the development and utilization of data.	35	41

Performance Analysis and Lessons Learned

In 2014–15, 41 scientific activities were supported in the field of Sun-Earth System Science (SESS). While the number of activities is the same as last year, the breakdown per SESS field differs slightly:

- Nine activities supported atmospheric sciences (down from 15 in 2013–14 due to reduced funding): three for SCISAT-1 and one for each of the following: **Environment Canada's Carbon Assimilation System (EC-CAS)**, OSIRIS (Sweden's Odin satellite), MOPITT (NASA's Aura satellite), **Canadian Ionosphere Atmosphere Model (C-IAM)**, **Wind Imaging Interferometer (WINDII)**, and **World Climate Research Programme (WCRP)**;

- 24 activities supported solar-terrestrial science (up from 19 in 2013–14): 18 for the **Geospatial Observatory (GO Canada)**, two for THEMIS (NASA's satellite), and one for each of the following: **a memorandum of understanding (MoU) for space weather with NRCan**, SWARM (ESA's suite of three satellites), Investigation of Cusp Irregularities – 4th sounding rocket campaign (ICI-4), and ePOP (CASSIOPE); and

- Eight activities supported surface sciences (up from seven in 2013–14): six for the Canadian Soil Moisture Active Passive (SMAP) mission and two for SWOT (NASA).

Also noteworthy is the fact that this indicator provides information on two types of SESS activities: those that generate data (the instruments) and those that analyze the data (research activities). Among the 41 aforementioned activities, there are 28 data generation (instrument development/operation – SSP 1.1.2.2) activities and 13 **data usage** activities (SSP 1.1.3.3.), which are highlighted **in bold**.

*As noted in the Budgetary Financial Resources table, the variance between 2014–15 planned and actual expenditures for Sub-Sub-Program (SSP) 1.1.3.3 mainly stems from a coding error in grant amounts ($260,000) for the Canadian Ionosphere Atmosphere Model, plus $640,000 for eight GO Canada grants, and $100,000 for a space weather MoU. The complementarity between the two SSP 1.1.2.2. and 1.1.3.3. led to grant expenditures being incorrectly coded. The issue has since been addressed and rectified.

To learn more about satellites visit the CSA's satellites web page.[iv]

Program 1.2: Space Exploration

Description

This Program provides valuable Canadian science, signature technologies and qualified astronauts to international space exploration endeavours. This Program contributes to the Government of Canada's Science and Technology Strategy. It fosters the generation of knowledge as well as technological spinoffs that contribute to a higher quality of life for Canadians. It generates excitement within the population in general and contributes to nation-building. This Program appeals to the science and technology communities. It is targeted mostly toward Canadian academia and international space exploration partnerships. Canadian industry also benefits from the work generated within this Program. This Program is delivered with the participation of foreign space agencies and Government of Canada (GoC) organizations. This collaborative effort is formalized under international partnership agreements and contracts.

Budgetary Financial Resources (dollars)

2014–15 Main Estimates	2014–15 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	2014–15 Difference (actual minus planned)
96,856,363	96,856,363	106,891,653	97,329,795	473,432

Human Resources (Full-Time Equivalents [FTEs])

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
179.5	164.4	(15.1)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Expansion of scientific knowledge acquired through space exploration endeavours.	1. Number of peer-reviewed scientific publications, reports and conference proceedings based on space exploration data produced by researchers (sciences and technologies) in Canada.	75	362
2. Multiple use and applications of knowledge and know-how acquired through space exploration endeavours.	1. Number of terrestrial applications of knowledge and know-how acquired through space exploration endeavours.	2	2
	2. Number of space re-utilizations of knowledge and know-how acquired through space exploration endeavours.	1	2

Performance Analysis and Lessons Learned

Space exploration missions are typically conducted by space agencies through international partnerships. The Agency's success in space depends on its ability to contribute to world-class science, technology and expertise. In order for Canada's space program to generate knowledge and economic returns and to be sustainable, a variety of elements are required, including a competitive industry that produces advanced technologies, highly qualified scientists who contribute to leading-edge research, terrestrial applications and spinoffs from space activities that positively impact the lives of Canadians, and strategic and timely positioning of Canadian science and technology with our international space partners. For example, Canada's Alpha Particle X-ray Spectrometer instrument, on board the Curiosity Rover, has been providing scientific data from the surface of Mars since 2012.

Canada's space program has achieved notable international success through Canadian scientists' contributions to space life sciences, space astronomy and planetary sciences. In 2014–15, a total of 362 peer-reviewed scientific publications were produced using information made available by the CSA's funded space exploration instruments. This is comparable to the 242 publications produced in 2013–14. The target of 75 peer-reviewed scientific publications was set in 2011 when the CSA implemented its new Program Alignment Architecture (PAA). Since the indicators and measuring tools were new (CSA annual Performance Result – Integrated Survey), a few years of data gathering was necessary to adjust the target adequately. Accordingly, the number of peer-reviewed publications has now been measured with the same tool for the past

two years, yielding similar results. Therefore, the target will be adjusted in light of those results in future reports.

In 2014–15, space exploration missions and programs generated two terrestrial applications for use in commercial markets. The first is a terahertz microscope used for breast cancer diagnosis, a spinoff of the investments made by the CSA to the Herschel space telescope. The second is a diagnostic tool used for a scalable nuclear fusion reactor based on the rapid scan Force Torque Sensor developed for the Herschel space telescope.

In addition, space exploration missions and programs generated two space re-utilization-of-knowledge applications used for space exploration endeavours. The first re-utilization application was the hydrate carbonaceous chondrite simulant for asteroid surface regolith, developed by the University of Calgary, and then used for NASA's asteroid sample return mission, Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx). The second case of re-utilization involved the manufacture of nanosatellites derived from the Canadian Microvariability and Oscillations of Stars (MOST) space telescope by the University of Toronto Institute for Aerospace Studies, which resulted in export sales to Poland and Austria.

Sub-Program 1.2.1: International Space Station (ISS)

Description

This Sub-Program uses the International Space Station (ISS)—a unique Earth-orbiting laboratory—to learn, to live and work in space while conducting scientific, medical and engineering studies. It includes the assembly and maintenance of the ISS through the use of the Canadian Mobile Servicing System (MSS) and the design, development and operations of payloads and technological demonstrations aboard the ISS. This Sub-Program is necessary to generate specific understanding and technological advances to prepare for the challenges of space exploration and for terrestrial benefits. This Sub-Program provides Canadian industry and academia privileged access to the ISS. This Sub-Program is performed in collaboration with Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort is captured under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
58,851,233	56,161,874	(2,689,359)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
98.8	89.0	(9.8)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Development of operational and technological know-how related to long-duration space missions (with potential Earth application) acquired through participation in ISS operations and laboratory missions.	1. Number of Canadian missions/solutions/instruments flown on the ISS.	10	10
	2. Percentage of Canadian missions/solutions/instruments flown on the ISS that met their mission requirements.	100%	100%
2. Canada, a well-positioned partner, influences the ISS program's direction.	1. Number of CSA's participation in ISS program boards and panels.	67	161

Performance Analysis and Lessons Learned

Ten missions/solutions/instruments were carried out and/or flown to the International Space Station (ISS) as planned. These missions/solutions/instruments were the result of combined efforts invested in two sub-sub programs, namely the assembly and maintenance operations of the ISS (1.2.1.1) and its utilization (1.2.1.2).

Consistent with previous years, Canada fulfilled 100% of its ISS missions by operating the Mobile Servicing System (MSS) and conducting its scientific research program aboard the ISS. Some examples of the missions performed by the MSS include three free flier captures and releases of the unmanned SpaceX Dragon, which delivered cargo to the ISS, and one capture and release of the Orbital Cygnus vehicle. The MSS also conducted a robotic maintenance activity

using Dextre to replace one of Canadarm2's failed cameras, a "first ever" in space. Furthermore, the CSA supported advanced robotic refuelling mission activities to demonstrate related technology and achieve operational objectives.

The CSA's managers represent Canada on multiple ISS governance and management boards. In 2014–15, Canada was represented more actively in the ISS governance structure than what was originally estimated. Determining the quantity of meetings in advance when the CSA is not the party convening the meetings explains the gap between the forecasted 67 participations and the actual 161.

Concretely, through the International Space Life Sciences Working Group, which is one of the ISS boards and panels, the CSA continued to work with the European Space Agency (ESA), the Japan Aerospace Exploration Agency (JAXA), NASA, the German Aerospace Center (DLR), the French Space Agency (CNES) and the Italian Space Agency (ASI) to coordinate multinational world-class scientific research on the ISS. The recent development of a performance measurement strategy for this program has identified alternative indicators which will be used in future planning and performance reports and will address the relevancy of indicators.

Canada's greater-than-planned participation led to successful negotiations with NASA to provide technologies and services that would offset Canada's share of the ISS Common System Operation Costs from 2016 through 2020. This activity helped leverage Canada's preparedness for future space exploration cooperation. This negotiation took two years, and the CSA delivered with respect to the GoC's decision in Budget 2012 to extend Canada's participation in the ISS to 2020.

Sub-Sub-Program 1.2.1.1: International Space Station Assembly and Maintenance Operations

Description

This Sub-Sub-Program includes the provision and operation of the Canadian Mobile Servicing System (MSS), composed of three Canadian robots – Canadarm2, Dextre and the Mobile Base System. MSS operations and maintenance services are conducted by Canadian or foreign astronauts on board the International Space Station (ISS) and by ground controllers and engineers located in established facilities at the Canadian Space Agency (CSA) and the National Aeronautics and Space Administration (NASA) – Johnson Space Center. This Sub-Sub-Program also includes the provision of specialized MSS training, systems engineering and software services, flight procedures development as well as the facility infrastructure necessary to operate the MSS through its life cycle. This Sub-Sub-Program is necessary to fulfill Canada's ongoing commitment to the international partnership to assemble and maintain the ISS, a legally binding obligation under the Canadian *Civil International Space Station Agreement Implementation Act*.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
53,037,468	51,710,048	(1,327,420)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
83.2	75.5	(7.7)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. The Canadian contribution (Mobile Servicing System) meets the planned operational requirements identified in the ISS Increment Definition Requirements Document (IDRD) in accordance with the Intergovernmental Agreement (IGA) and the NASA/CSA MOU.	1. Percentage of operational requirements fulfilled.	100%	100%

Performance Analysis and Lessons Learned

Once again, Canada fulfilled 100% of its International Space Station (ISS) operational missions by operating the Mobile Servicing System (MSS) to meet ISS scheduling requirements. To accomplish this, Canada continued to maintain and provide technical support for MSS hardware and software, repaired and overhauled failed hardware on an ongoing basis, provided MSS-related training and qualification for astronauts and ground support personnel, planned and supported MSS operations, and conducted operations in conjunction with the NASA Houston flight control room from the Remote Multi-Purpose Support Room in St-Hubert, Quebec. Canada continued to update MSS software to provide additional capabilities to reduce analysis requirements during mission preparation and give more autonomy to MSS operators.

The MSS has been on-orbit since 2001. Its age, combined with the harsh environment of space, is beginning to create issues in terms of risk and supportability of the system. The two system issues, that preoccupy engineers, are replacing MSS cameras when they fail and dealing with the degraded mechanical performance in the aging Canadarm-2 End-Effectors (i.e. hands).

Some commercial vendors have ceased production of parts that were available in 2001. The cameras are one such example. Canada has taken measures to mitigate this risk by putting in place a contract to procure new cameras to replace the older design. This proactive approach ensures that the obsolescence of critical parts does not adversely impact Canada's ability to meet its obligations to the ISS in the future.

The degraded Canadarm2 End-Effectors are another manifestation of a system aging in the harsh environment of space. Canada has worked with NASA to understand the cause of the degradation and to develop corrective actions. Astronauts aboard the ISS conducted spacewalks to lubricate and improve the performance of the End-Effector mechanisms. Canada will continue to meticulously monitor the performance of the MSS to mitigate the risk of further obsolescence.

*As noted in the Budgetary Financial Resources table, the variance of $1.3 million is mainly due to an internal reallocation between sub-sub-programs 1.2.1.1 and 1.2.2.3 in order to present the Common Systems Operations Costs obligations in the appropriate program once negotiations with NASA were completed.

Sub-Sub-Program 1.2.1.2: International Space Station Utilization

Description

This Sub-Sub-Program encompasses the implementation of scientific, operational, medical and technological studies in specific areas, such as life sciences, radiation, material or fluid sciences, to be conducted aboard the International Space Station (ISS) by Government of Canada (GoC) organizations, academia or the private sector. The ISS offers them the advantages of an orbiting platform with human presence and prolonged microgravity exposure. This Sub-Sub-Program is necessary for testing novel technologies and conducting scientific studies in the unique environment of the ISS, leading to a better understanding of long-duration space missions and to potential terrestrial benefits. This Sub-Sub-Program is performed in collaboration with GoC organizations and foreign space agencies. This collaborative effort is captured under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
5,813,765	4,451,826	(1,361,939)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
15.6	13.5	(2.1)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Optimal utilization of the ISS.	1. Percentage of programmatic objectives achieved through ISS utilization.	80%	40%
	2. Number of Canadian stakeholders involved in activities on the ISS.	3	10
	3. Proportion of ISS resources used.	60%	96%

Performance Analysis and Lessons Learned

In 2014–15, only 40% of the program objectives were achieved because the launch of Space-X6 was delayed for technical reasons. Therefore, out of the five potential program fields (science, operational, technology, education and outreach), only two out of the projected four were addressed with the instruments flown in 2014–15. The ISS supported the science and operational fields with the following payloads: (a) Vascular, a weightless environment experiment to study what triggers inflammation aboard the ISS that could damage the heart and blood vessels, in order to help assess the long-term risks of human space flight; and (b) Blood Pressure Regulation Experiment (BP Reg), designed to validate a simple in-flight method to test the risk of fainting upon return to Earth after a long-duration space flight. In the operational field, Radi-N2 was carried out, an experiment aimed at measuring neutron radiation levels aboard the ISS. The two remaining program objectives, technology and education, will be reached next year with the Tomatosphere IV and Microgravity Vibration Isolation System testing projects.

There were ten Canadian stakeholders involved in the 2014–15 activities on the ISS: University of Waterloo, University of Ottawa, Simon Fraser University, Royal Military College, University of Ontario Institute of Technology, Ryerson University, University of Calgary, University of British Columbia, Bubble Technology Industries Inc., and Magellan Aerospace. The increase in the number of stakeholders resulted from an overlap between ISS activities that were coming to an end and new activities. The current level of stakeholders will remain constant for the next two years, and reflects a sustainable level of CSA-sponsored ISS activity.

Available crew time is the resource that most strongly constrains ISS utilization. As a result, the proportion of the crew time allocated to the CSA and used in a given period is a measure of the CSA's success in using ISS resources available to Canada.

During the period covered by this report, Canada's use of its crew time allocation was 96%, an increase over the 60% target. This increase stemmed from the BP Reg experiment, which

required additional time, and because the Radi-N2 experiment was frequently used to fill gaps in the ISS crew schedule.

*As noted in the Budgetary Financial Resources table, the variance of $1.3 million mainly stems from a more rigorous governance process for CSA initiatives, resulting in particular in a new procurement strategy for the Life Science Research System. Also, the planned technical demonstration of the Microgravity Vibration Isolation Subsystem was postponed at the request of the European Space Agency, while planning refinements reduced funding required for International Life Sciences Research Announcements in 2009.

Sub-Program 1.2.2: Exploration Missions and Technology

Description

This Sub-Program encompasses the development and use of astronomy and planetary missions as well as the development of advanced exploration technologies. This Sub-Program is necessary as it contributes valued Canadian signature technologies to international space exploration endeavours and generates a better understanding of the universe, the solar system and our home planet. It could also lead to technology transfers for terrestrial benefits. This Sub-Program provides Canadian industry and academia with unique opportunities through their participation in international space exploration initiatives. This Sub-Program is performed in collaboration with foreign space agencies, Government of Canada (GoC) organizations and through CSA participation in international groups, such as the International Space Exploration Coordination Group. This collaborative effort takes shape under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
33,508,940	37,381,502	3,872,562

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
67.1	59.9	(7.2)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Technological know-how is acquired through Space Exploration endeavours (Astronomy and Planetary).	1. Proportion of the CSA's missions/solutions/instruments that met their mission performance requirements at acceptance review and/or at commissioning.	1	1
2. Canada maintains a strategic positioning which supports its capacity to influence space exploration missions and decision-making processes in key international space exploration forums.	1. Number of CSA sponsored Highly Qualified Personnel (HQP) nominated on International Space Exploration decision bodies.	8	18
3. CSA's participation in space exploration missions provides access to scientific data about the solar system and the universe.	1. Number of CSA's sponsored astronomy and planetary missions' providing data to Canadian scientific community	4	4

Performance Analysis and Lessons Learned

The CSA delivered Canada's contribution to JAXA's X-ray Space Observatory space telescope (ASTRO-H), the Canadian ASTRO-H Metrology System, which is being integrated into the spacecraft. The system will continue to undergo testing prior to the planned launch in 2015–16, and has met all performance requirements to date.

A total of 18 Highly Qualified Personnel (HQP), sponsored by the CSA, sat on strategic international space exploration committees, ensuring that Canadian experts have a voice in determining Canada's contribution to future space exploration missions. The target will be reviewed in future reports to increase planning accuracy.

In 2014–15, the following four CSA-sponsored astronomy and planetary missions provided data to Canadian and international scientific communities:

- MOST, whose goal is to help us understand the behaviour of stars through their microvariability and oscillation. This mission has been running successfully for over ten years, and 2014–15 was the last year of operation supported by the CSA;

- The Alpha Particle X-ray Spectrometer, developed to determine the chemical composition of various soil, dust and rock samples on Mars. A Canadian instrument on board the Curiosity Rover, which is part of the Mars Science Laboratory;
- Analysis of data from the Hershel and Plank space telescopes. While both space observatories completed their science observations in 2013, their rich datasets continue to be exploited for plentiful new insights about the cosmos; and
- Following a successful launch in 2013, the Near-Earth Object Surveillance Satellite (NEOSSat) reached initial operating capability in February 2015. At the time this report was being written, the flight operation team, along with the science team, were improving system robustness to reach the expected operating capability.

Sub-Sub-Program 1.2.2.1: Space Astronomy Missions

Description

This Sub-Sub-Program encompasses the definition, design, technology development, implementation and use of Canadian scientific instruments and signature technologies made available to Canadian and international space astronomy missions. This Sub-Sub-Program is necessary to perform space astronomy investigations and generate data and new knowledge about the universe. This Sub-Sub-Program is performed in collaboration with foreign space agencies, Government of Canada (GoC) organizations and through consultations with the Canadian astronomical community. This collaborative effort takes shape under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
11,367,365	14,169,914	2,802,549*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
14.3	6.0	(8.3)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Canadian know-how and expertise allow Canada to lead or participate in international space astronomy missions.	1. Number of technological and scientific solutions being developed by the CSA in the context of astronomy missions.	1	2

Performance Analysis and Lessons Learned

Canada is contributing to two key international astronomy missions, namely NASA's James Webb Space Telescope (Webb) and JAXA's ASTRO-H mission.

NASA's Webb, the successor to the highly successful Hubble Space Telescope, is a major space observatory to be launched in 2018. Canada's space sector is responsible for designing, developing and producing both the Fine Guidance Sensor, which will ensure the very precise pointing of the telescope, and the Near-Infrared Imager and Slitless Spectrograph science instrument. While both instruments were delivered to NASA in July 2012, the CSA continued to support the integration of the flight instruments on board the Webb. Through the CSA's contribution, Canadian astronomers will have guaranteed access to 5% of the observing time of the Webb.

JAXA's ASTRO-H mission, an X-ray space astronomy telescope, is scheduled for launch in 2016. Canada is responsible for designing, developing and producing the Canadian ASTRO-H Metrology System (CAMS). Built by Canada's space sector, CAMS was delivered to JAXA in January 2015. This mission also involves participation from Europe and NASA. The CSA's participation will enable Canadian scientists to apply for observation time on the telescope.

In addition to these two missions, the CSA has also been working on improving the performance of the Near-Earth Object Surveillance Satellite (NEOSSat), which was launched in 2013. NEOSSat is a microsatellite jointly sponsored by the CSA and Defence Research and Development Canada. Through NEOSSat, Canada is contributing to the international effort to acquire useful metric (position/time) data on near-Earth orbiting objects (asteroids) and man-made objects (spacecraft and space debris) to subsequently catalogue them in order to maintain the safety of Canadian and international assets, both civilian and military. Efforts continue to be made at this time to achieve operational status and meet science objectives.

*As noted in the Budgetary Financial Resources table, the variance of $2.8 million is mainly due to the cash flow requirements for the Webb and CAMS projects.

Sub-Sub-Program 1.2.2.2: Planetary Missions

Description

This Sub-Sub-Program encompasses the definition, design, technology development, implementation and use of Canadian scientific instruments and signature technologies made available to international exploration missions. The Sub-Sub-Program is necessary to reach exploration destinations such as planets and asteroids or new exploration platforms to conduct planetary science investigations, to generate data and new knowledge and to conduct engineering and/or planetary resource management activities. This Sub-Sub-Program is performed in collaboration with the international space exploration community, Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort takes shape under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
12,626,310	10,508,796	(2,117,514)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
12.7	9.5	(3.2)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Canadian know-how and expertise allow Canada to participate in planetary exploration missions.	1. Number of technological and scientific solutions being developed by the CSA in the context of planetary missions.	1	1

Performance Analysis and Lessons Learned

NASA's OSIRIS-REx spacecraft will be launched to an asteroid named Bennu (1999 RQ36) in 2016. OSIRIS-REx will execute precise spacecraft manoeuvres to navigate to the surface of this carbonaceous primitive asteroid, retrieve samples of pristine regolith and return that sample to Earth. The purpose of such scientific studies and analyses is to contribute to a better understanding of the solar system's formation and the origins of life. The Canadian contribution

to NASA's asteroid mission is the OSIRIS-REx Laser Altimeter (OLA), an advanced scanning light detection and ranging system that will be an important navigational aid by providing high-resolution topographic mapping of the asteroid surface. Designed and produced by Canada's space sector, OLA will map the dimensions of the asteroid from a distance of between 7 km and 500 m, resulting in a highly accurate three-dimensional model of the targeted asteroid.

In 2014–15, the OLA engineering model was tested and the critical design review was successfully conducted. In addition, the expenditure authority for the implementation phase of the OLA project was provided.

Owing to programming reasons, the OLA project was initiated later than expected, putting pressure on the overall OLA project schedule.

*As noted in the Budgetary Financial Resources table, the variance of $2 million is mainly due to cash flow requirements for the OLA project.

Sub-Sub-Program 1.2.2.3: Advanced Exploration Technology Development

Description

This Sub-Sub-Program includes the development of advanced Canadian signature technologies to be used in potential astronomy and planetary missions that could be destined for the Moon, Mars, asteroids or other celestial bodies. This Sub-Sub-Program is necessary to shape or determine the nature of Canada's contribution to potential international exploration and astronomy missions and could lead to spinoffs. In addition, the Sub-Sub-Program includes terrestrial deployments in analogue sites that offer geological similarities with Martian or Lunar surfaces, where this technology and its operational aspects are being tested and where exploration-related science is conducted for proof of concepts. This Sub-Sub-Program is performed in collaboration with foreign space agencies and Government of Canada (GoC) organizations and through the Canadian Space Agency's participation in international groups, such as the International Space Exploration Coordination Group. This collaborative effort takes shape under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
9,515,265	12,702,792	3,187,527*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
40.0	44.4	4.4

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Maturing science, technology and operational solutions for planning and strategic positioning purposes.	1. Number of science, technology and operational solutions that are under development in conformity with the orientations and conclusions of the Canadian Space Exploration strategic plan.	9	31

Performance Analysis and Lessons Learned

The CSA's Space Exploration Program prepares Canadian industry and research organizations for future exploration missions. The CSA continued to develop concepts for planetary, astronomy and human space flight beyond low Earth orbit. The CSA deployed terrestrial rover prototypes in its planetary analogue terrain and at selected test sites. The CSA continued to develop medical concepts of operations as well as medical technologies and procedures for human space flight. The CSA also initiated prototyping activities and supported multiple analogue mission deployments, working in collaboration with industrial and academic partners.

Science, technology and operational solutions under development include two science definition studies, six concept studies, ten prototype developments, five analogue missions and eight initial studies, for a total of 31 solutions. The actual results of this Sub-Sub-Program (SSP) continued to be higher than expected, mostly because some concept studies, science definition studies and initial phase studies were added after targets were set. Furthermore, following a prioritization process, additional funding was allocated during the year, enabling the CSA to broaden its portfolio of studies and move ahead of scheduled activities planned for later.

This SSP delivers results that will help the CSA make informed decisions about commitments to future space exploration missions and that will help reduce technical, financial and scheduling risks to these future missions.

An action plan was initiated in 2013–14 in response to the recommendations of an evaluation of the Advanced Exploration Technology Development Program released in February 2014. The main action following this evaluation is the consolidation of the CSA's technology development activities under a single sector of the CSA.

*As noted in the Budgetary Financial Resources table, the variance of $3 million is mainly due to internal reallocations between SSPs 1.2.1.1 and 1.2.2.3 in order to present the Common Systems Operations Costs obligations under the appropriate program after negotiations with NASA were completed. Internal reallocation of surpluses enabled us to start work earlier to facilitate cash flow management in the following year.

Sub-Program 1.2.3: Human Space Missions and Support

Description

This Sub-Program encompasses all activities required to recruit, develop, train and maintain a healthy and highly qualified Canadian astronaut corps capable of participating in space exploration missions. It also includes all activities directed at mitigating health risks associated with those missions, such as the development of advanced technologies to be used in support of human space missions. This Sub-Program is necessary to generate specialized knowledge in fields that sustain human space flights, such as life sciences and space medicine. Furthermore, by exploring technological solutions to the various challenges of human space flight, this Sub-Program could contribute to alternate health care delivery mechanisms for terrestrial applications. This Sub-Program is performed with Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort is formalized under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
4,226,190	3,786,419	(439,771)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
13.6	15.5	1.9

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Human space flight generates "unique" health and life science knowledge, and technological know-how to sustain life and mitigate health risk during long-duration space flight.	1. Number of activities that lead to health risk mitigation strategies, technologies and/or countermeasures.	16	12

Performance Analysis and Lessons Learned

Momentum continues to build in the delivery of this Sub-Program, with a focus on optimizing Canada's access to the International Space Station. The international collaborative selection process of four of the projected 16 activities was longer than expected. However, the other 12 activities are either at the planning, early implementation or completion phases. Most of these experiments take place on board the ISS, resulting in a stronger and more visible Canadian presence in the orbiting laboratory on a continuous basis.

Canadian astronauts continued their training and performed many collateral duties in support of human space flight activities. They also took part in several communication events in Canada, such as presentations in schools, thereby stimulating interest in space activities and attracting the younger generation to science, technology, engineering and mathematics.

The Human Space flight Consultative Committee, made up of Canadian stakeholders from Canadian industry, academia and government, held its first in-person meeting in December 2014, providing advice on the evolution of Canadian human space flight activities.

The new governance process for CSA initiatives led to a more structured approach to decision making for project approval yet had an impact on scheduled approval timelines. This new reality will be taken into consideration for the scheduling of upcoming activities.

Sub-Sub-Program 1.2.3.1: Astronaut Training and Missions

Description

This Sub-Sub-Program encompasses activities associated with all phases of an astronaut's career from recruitment to retirement, including space missions. This Sub-Sub-Program includes the management of National Astronaut Recruitment Campaigns; the implementation of individualized astronaut career management plan; the implementation of basic, advanced and mission-specific training; collateral duties assignment; space mission negotiations and assignment; as well as all the logistical, administrative and operational support activities in the pre-flight, in-flight and post-flight periods. This Sub-Sub-Program is necessary to live and work in a space environment and in order to further our understanding of human behaviour and health in space, and to conduct experiments and collect space-based scientific data useful to the science community. This Sub-Sub-Program is performed with Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort is formalized under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
2,583,515	2,078,971	(504,544)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
9.5	9.4	(0.1)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Canadian astronauts corps is ready to assume any responsibilities on an expedition to the International Space Station (ISS).	1. Number of astronaut activities undertaken in preparation for eventual ISS mission assignments.	4	8

Performance Analysis and Lessons Learned

While awaiting assignment to a space mission, Canadian astronauts undergo a rich and varied training program, fulfilling operational and strategic collateral duties at NASA's Johnson Space Center (JSC) in order to ensure that they are fully ready to assume all mission responsibilities once they are assigned to an expedition aboard the International Space Station (ISS).

In 2014–15, eight such activities were undertaken by Canadian astronauts. The target was exceeded, as the CSA chose to take advantage of this period of time where no Canadian astronauts were on a space mission or training for a space mission to better prepare the astronaut corps for future mission assignments. These activities included robotics training at the CSA (to qualify our astronauts to operate Canada's robotics assets aboard the ISS), expedition-type training (field geology training in remote Canadian regions and NASA Extreme Environment Mission Operations [NEEMO], which take place in an underwater habitat), ISS pre-assignment training (including ISS systems), survival training (including water and winter survival), medical training, Russian language training (a requirement for all ISS crew), flight training and collateral duties such as lead capcom[8] roles, as well as a lead role in the development of a new training event called Space Week (a realistic training activity which simulates life and operations aboard the ISS for astronauts and support personnel).

Both Canadian astronauts, LCol Hansen and Dr. Saint-Jacques, are qualified and ready for assignment to a space mission.

In addition, in order to actively support activities and programs aligned with the "Inspiring Canadians" principle outlined in Canada's Space Policy Framework, the two Canadian astronauts took part in speaking engagements to motivate young Canadians to pursue careers in science, technology, engineering and math.

Sub-Sub-Program 1.2.3.2: Operational Space Medicine

Description

This Sub-Sub-Program delivers operational and clinical health care activities during all phases of basic, advanced and mission-specific training as well as during the pre-flight, in-flight and post-flight periods. It also promotes and ensures the physical, mental, social well-being and safety of Canadian astronauts. This Sub-Sub-Program is necessary to ascertain the overall health of Canadian astronauts and to monitor long-term health status. This Sub-Sub-Program is performed

[8] Capcom: A Capsule Communicator communicates directly with the crew of a manned space flight

with Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort is formalized under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
961,650	808,720	(152,930)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
1.3	3.1	1.8

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Astronauts' health is optimized to meet mission requirements.	1. Number of active astronauts medically certified for ISS assignment and duties.	2	2
2. Astronauts' long-term health is monitored following their active careers.	1. Percentage of eligible astronauts participating in their long-term health monitoring.	25%	63%

Performance Analysis and Lessons Learned

The CSA continued to monitor and coordinate medical support with international partners and actively supported the International Space Station (ISS) medical boards, panels and working groups. The CSA continued to provide comprehensive medical and operational support (clinical, human behaviour and performance, exercise countermeasure) to the Canadian astronaut corps to optimize their health and readiness for space missions. As mentioned earlier, both Canadian astronauts, LCol Jeremy Hansen and Dr. David Saint-Jacques, are qualified and ready for assignment to a space mission.

Furthermore, the CSA renewed a memorandum of understanding with Health Canada to perform radiation biodosimetry analysis on Canadian and European Space Agency (ESA) astronauts assigned to ISS missions.

Since missions to the ISS for Canadian astronauts are few, it is important for the CSA to maintain the skills required to provide adequate and up-to-date medical support on the ISS. The

CSA is developing/implementing agreements with ISS partners to leverage Canadian expertise for training and mission support opportunities.

The participation of retired astronauts in health monitoring studies (Longitudinal Study of Astronaut Health) is voluntary. In 2014–15, eight astronauts were eligible to participate. The target was set at one astronaut per year for participation in the study. In 2014–15, five out of eight astronauts chose to participate.

The participation of retired astronauts in the Longitudinal Study of Astronaut Health is voluntary and hence difficult to predict. This aspect will be taken into account in future reports with a minor modification to the performance indicator from "Percentage of eligible astronauts participating in their long-term health monitoring" to "Percentage of astronauts voluntarily participating in long-term health monitoring who received support from the CSA," with a target of 100%.

Sub-Sub-Program 1.2.3.3: Health and Life Sciences

Description

This Sub-Sub-Program encompasses space medicine and life science activities that explore health care delivery and life sustainability solutions on future long-duration exploration missions. These benefits are targeted at the space exploration community, mainly academia and partnering agencies. This Sub-Sub-Program develops collaborative projects with academia and industry. It uses analogue sites that offer relevant similarities with the harsh environment of space, and where exploration-related medical and life science studies are conducted. This Sub-Sub-Program is necessary to identify, understand, mitigate or eliminate health risks associated with human space flights, and to understand and address the needs of humans during those missions. The solutions could also be offered as alternative health care delivery mechanisms for terrestrial benefits through the transfer of space technology. This Sub-Sub-Program is performed with Government of Canada (GoC) organizations and foreign space agencies. This collaborative effort is formalized under contracts and/or international partnership agreements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
681,025	898,728	217,703

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
2.8	3.0	0.2

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Performance of space life sciences studies with potential benefits for Canadians and to enable human exploration of space.	1. Number of studies aiming at the development of countermeasures and enhanced human performance and life support.	6	6
	2. Number of partnerships addressing potential terrestrial health care solutions.	2	2

Performance Analysis and Lessons Learned

Throughout 2014–15, the CSA continued to work with the European Space Agency on planning the next program of bed-rest campaigns in Europe, as well as the next suite of isolation studies to be carried out in the over-wintering phase of the Concordia Antarctic Research Station. An announcement of opportunity related to bed rest and isolation, issued in October 2013, resulted in the selection of six studies by ESA in 2014–15, with the objective of clarifying the mechanisms of bed-rest-induced muscle atrophy, cardiovascular dysfunction and anaemia, and of supporting research into the psychological impact of prolonged isolation. The findings will be applied to analyze the risk of human space flight and will then be transferred to applicable rehabilitation therapy and other important medical fields here on Earth.

The partnership with the Canadian Institute of Health Research (CIHR) remains in effect through the Regenerative Medicine and Nano-medicine Initiative. A memorandum of understanding (MOU) has been established between the CSA and the CIHR Institute of Aging. It will cover CSA-CIHR collaborations that will explore the commonalities in physiological and socio-psychological changes experienced in space flight and as part of the aging process.

Furthermore, a MOU with the National Research Council's Medical Devices section was signed in 2014–15, which will allow the NRC and the CSA to develop microfluidics-based technology for the purification and separation of specific types of biomolecules from complex samples such as human blood. This capability is required for human research in space, both in the current ISS

research environment and in future human space exploration missions, as it also has the potential to create significant terrestrial applications in medicine.

To learn more about space science and exploration, visit the CSA's space and exploration activities web page.[v]

Program 1.3: Future Canadian Space Capacity

Description

This Program attracts, sustains and enhances the nation's critical mass of Canadian space specialists, fosters Canadian space innovation and know-how, and preserves the nation's space-related facilities capability. In doing so, it encourages private–public collaboration that requires a concerted approach to future space missions. This Program secures the nation's strategic and ongoing presence in space in the future and to preserve Canada's capability to deliver internationally renowned space assets for future generations. It is targeted at Canadian academia, industry and youth, as well as users of Canadian space solutions (Government of Canada [GoC] organizations) and international partners. This Program is conducted with the participation of funding agencies, GoC organizations along with government facilities and infrastructure, foreign space agencies, not-for-profit organizations and provincial governments. This collaborative effort is formalized under contracts or national and international partnership agreements. This Program is funded through the Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology.

Budgetary Financial Resources (dollars)

2014–15 Main Estimates	2014–15 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	2014–15 Difference (actual minus planned)
62,772,518	62,772,518	63,376,550	58,018,955	(4,753,563)

Human Resources (Full-Time Equivalents [FTEs])

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
92.4	89.5	(2.9)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Canada holds a space community (academia, industry and government) able to contribute to the sustained and strategic Canadian use of space.	1. Number of FTEs in the Canadian space sector.	3,500 HQP	4,360 HQP
	2. Monetary value of the Canadian space sector R&D investments.	$60 million	$180 million
	3. Degree of match between workforce supplied and industry workforce requirements.	Target to be established.	Not measured

Performance Analysis and Lessons Learned

Although the annual Canadian space sector report was not published in 2014, the data were collected from the space community. The results showed that 4,360 Highly Qualified Personnel (HQP) contributed to the sustained and strategic use of space. And even though the indicator refers to number of Full-Time Equivalents (FTEs), data collected each year identify HQP. This clarification confirms that reporting is consistent and enables trend analyses.

The second indicator provides the monetary value of all Research and Development (R&D) investments in the Canadian space sector from both internal and external sources for a given organization. The results in this report are slightly higher than in 2013–14 ($165 million), which correlates with an increase in one of the Agency's R&D program budgets, Enabling Technology Development (1.3.2.2). The difference between the target ($60 million) and the actual result ($180 million) stems from the initial methodology used to establish the target. The methodology considered only external financial sources of R&D. The trend over the past two years will be reflected in future target setting.

Following a study aimed at setting a benchmark to establish to what extent the workforce supply meets the industry's workforce demands, the conclusions revealed that this indicator presented too many challenges to satisfactorily measure on an annual basis. As a result, this indicator will no longer appear in future reports. Aside from this finding, the report (Hickling) concluded that Canadian industry is generally very satisfied with the quality of graduates from Canadian post-secondary education institutions and that graduate-level education provides a high quality of research training and experience.

Sub-Program 1.3.1: Space Expertise and Proficiency

Description

This Sub-Program includes the development and enhancement of Canada's space capacity. This Sub-Program supports research in private or public organizations and sustains the development of Highly Qualified Personnel (HQP) in science and engineering. We encourage scientists and engineers to perform relevant development activities in space science and technology, and to develop their know-how by offering them financial support to sustain their research project and access to infrastructure devoted to world-class research and training, among which fast execution and small-size missions offer frequent flight opportunities. This Sub-Program is necessary to create and sustain a pool of space expertise and proficiency that will form the next generation of space professionals and workers and to provide solutions for future Canadian space endeavours. This Sub-Program is delivered with the participation of funding agencies, Government of Canada (GoC) organizations, foreign space agencies and not-for-profit organizations. This collaborative effort is formalized under national and international partnership agreements or contracts. This Sub-Program is funded through the Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
12,234,555	10,795,806	(1,438,749)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
44.1	38.1	(6.0)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. A pool of space experts and professionals is sustained and enhanced.	1. Number of scientists and engineers involved through opportunities provided by the program.	Target was not yet established**	284

2. Research is conducted in priority areas.	1. Number of research projects conducted through opportunities provided by the program.	Target was not yet established**	21
3. Advancement of Science & Technology solutions for future space initiatives.	1. Number of peer-reviewed papers, reports and conference proceedings acknowledging CSA support.	Target was not yet established**	34

Performance Analysis and Lessons Learned

For the past seven years, the CSA has collected data annually from scientists and engineers involved in research, awareness and learning in Space Science and Technology projects. In 2014–15, the results showed a total of 284 faculty members (students, scientists, engineers, research assistants and technicians) involved in 21 projects supported by the Sub-Program. Projects were identified through announcements of opportunity, and some were created as a result of unsolicited proposals. The primary funding mechanism was grants, mainly directed toward universities. The activities fall under four groups: academic development activities, aimed at clusters of three or more principal investigators from three or more organizations; collaborative research, targeting industrial research chairs; the Flights for the Advancement of Science & Technology (FAST), for suborbital missions; and research infrastructure activities, in the form of interdepartmental collaboration that provides scientists with access to specialized research facilities.

In 2014, the CSA's support was acknowledged in 34 peer-reviewed publications and reports with respect to the advancement of science and technology solutions for future space initiatives, which represent a sustained effort over multiple years.

As a prime example of the CSA's support in the development of HQP, the Stratospheric Balloon (Stratos) project provided 45 HQP with training opportunities in the private sector and academia. The first official CSA Stratos scientific and technological balloon launch campaign, stemming from a partnership between the CSA, the Centre national d'études spatiales and the City of Timmins, was held in the summer of 2014. Over a six-week period, seven stratospheric balloons were successfully launched and recovered after their missions from the CSA's recently constructed balloon launch base in Timmins, Ontario. A total of ten Canadian payloads were flown on board two gondolas to conduct R&D in line with the priority areas of space technology. These scientific instruments and generic technologies continue to advance science and technology solutions for future Canadian space initiatives, significantly reducing the overall risk for future space missions, while maintaining a pool of space experts at the forefront of their fields.

Also noteworthy, the Stratos project received the 2014 IPAC/Deloitte Public Sector Leadership Silver Award, which recognizes organizations that have demonstrated outstanding leadership by taking bold steps to improve Canada through advancements in public policy and management.

*As noted in the Budgetary Financial Resources table, the variance of $1.4 million is mainly due to lower costs for the Stratos project as well as revised cash flow requirements.

**The CSA first introduced this indicator in the 2013–14 Report on Plans and Priorities (RPP) but was unable to establish an accurate target as planned in that RPP. Therefore, the 2014–15 results provide the benchmark that will be used for future planning and performance reports.

Sub-Program 1.3.2: Space Innovation and Market Access

Description

This Sub-Program includes the development and enhancement of Canada's space capacity through innovation and market positioning. Through leading-edge technology and facilities, and international arrangements, the Sub-Program improves Canadian industrial competitiveness so that space users are continuously well served through constantly improving optimal and cost-effective space solutions. This Sub-Program is necessary to foster entrepreneurship that enhances Canadian industry's international positioning on commercial and government markets. This Sub-Program is performed with industry and is formalized under contracts or contributions. Foreign space agencies are partners in this endeavour, so that Canadian industry can access foreign markets through innovation or international arrangements.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
44,426,788	42,411,514	(2,015,274)

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
15.4	19.2	3.8

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Through innovation and international arrangements, Canadian industry is well positioned on international commercial and government markets.	1. Number of Canadian companies exporting space-related goods and services.	50	53
	2. Value of Canadian space-related goods and services exported.	$1.7 billion	$1.6 billion
2. Enhanced Canadian industry competitiveness.	1. Number of Canadian companies successfully obtaining national/international work orders.	100	81

Performance Analysis and Lessons Learned

The annual survey on the *State of the Canadian Space Sector* reported that 53 Canadian companies reported combined total revenues of $1.6 billion from their exports of space-related goods and services in 2013. This export value was rounded up for reporting purposes but in fact, there was a 5% increase compared with the data collected in 2012 ($1,639,000,000 in 2013 vs $1,584,000,000 in 2012). This increase can be explained with nine additional companies reporting export activities compared to 44 in 2012.

A total of 81 Canadian companies successfully obtained national/international work orders, compared with 83 in 2012. The results will be further analyzed for future target setting.

In 2014–15, the CSA continued to support space innovation and access to markets through its partnership with the European Space Agency (ESA), and received a favourable return on investment in comparison to other ESA member states. The Canadian space companies that enjoyed success with ESA participated in the following programs: Earth Observation (in particular with Canadian Synthetic Aperture Radar [SAR] technologies for the ground segment of Sentinel 1), the General Space Technology Program (for the formation flying mission Proba 3), Aurora planetary exploration programs (ExoMars mission), the Life and Physical Science Program (ELIPS), and the European Advanced Research in Telecommunications Systems (ARTES) program. Further results from Canada's partnership with ESA are found under Sub-Sub-Program 1.3.2.1.

Sub-Sub-Program 1.3.2.1: International Market Access

Description

This Sub-Sub-Program consists in facilitating foreign market access by the Canadian space industry through negotiating, implementing and managing special international arrangements. For example, in return for Canadian Space Agency (CSA) monetary contributions to the European Space Agency (ESA) under the long-lasting ESA–Canada Agreement, Canadian industry obtains some of the contracts awarded by ESA; thus penetrating a market that would otherwise be limited to Europeans. This Sub-Sub-Program is necessary as it results in increased access to foreign government market share for Canadian industry. This Sub-Sub-Program is delivered through concluding international agreements, trade measures, or other mutually beneficial arrangements that create a favourable political or trade environment that facilitates access to global markets.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
27,907,043	30,296,124	2,389,081*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
2.4	3.2	0.8

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Canadian investments through the ESA Agreement allow Canadian industry to access the institutional European market	1. Canadian industrial return coefficient (Ratio between the actual value of contracts awarded by ESA to Canadian organizations and the ideal value of contracts awarded by ESA to Canadian organizations).	96% or higher	99%
2. The Canadian industry has access to flight opportunities for its space technologies/components.	1. Number of technologies or components developed by Canadian industry which have been space qualified and/or have acquired flight heritage through Canada's participation in ESA programs.	5 opportunities over the duration of the agreement (2012–19)	No flight opportunities.

Performance Analysis and Lessons Learned

The reported industrial return coefficient is cumulative and covers the period from January 1, 2000, to December 31, 2014. For this period, Canada has achieved a return coefficient of 99%, which is much higher than the minimum guaranteed to European Space Agency (ESA) member states (96%) and very close to the ideal value (100%). This indicates that Canada was successful at obtaining its fair share of ESA contracts.

Four technologies/components have flown on ESA missions since the beginning of the current agreement (2012–19) and, while there were no flight opportunities for Canadian industry in 2014–15, two Canadian companies contributed major components of the ground segment for the Sentinel-1 satellite, launched on April 3, 2014.

*As noted in the Budgetary Financial Resources table, the variance of $2.3 million is mainly due to increased payments toward the cooperation agreement with ESA.

Sub-Sub-Program 1.3.2.2: Enabling Technology Development

Description

This Sub-Sub-Program consists of technology development and demonstration activities that contribute to maintaining or developing a technological edge in promising fields, such as switches, batteries, launchers, antennas, solar panels, etc. This Sub-Sub-Program is necessary as the enabling (generic) technology developed reduces costs and technological risks on multiple mission types, enhances the efficiency or performance of already established space solutions, and facilitates the commercialization of new products through innovation. This Sub-Sub-Program is performed with industry and is formalized under contracts or contributions.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
16,519,745	12,115,390	(4,404,355)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
13.1	16	2.9

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Increased technological capability of Canadian industry.	1. Number of different technologies addressed.	30	33

Performance Analysis and Lessons Learned

In 2014–15, the CSA continued to develop 33 different technologies, of which 32 had proven to have enough potential in the previous years to further their development. These technologies, developed either by Canadian industry or research organizations, aim at reducing the technical uncertainties related to potential future missions of Canadian interest.

In June 2014, the Enabling Technology Development Program (1.3.2.2), previously known as the Space Technologies Development program (STDP), issued an announcement of opportunity (AO). The responses to this AO resulted in 38 non-payable contribution agreements, with more

than 20 companies willing and able to tackle further priority areas (e.g. optics, robotics, satellite communications and space-based radar) representing more than $13 million over the span of three consecutive fiscal years. These contributions aim at increasing the commercial potential of Canadian space companies and securing their fair share of the global space economy.

In the same vein, at the beginning of the year, 30 technologies were made available for transfer through commercial Web platforms such as Flintbox and SparkUp. As a result, five technology transfer licences were concluded between Canadian industry and academia.

As laid out in the last STDP evaluation report,[vi] the management team continued to implement many of the recommendations, such as clearly planning missions and their related research and development requirements in terms of technology. Thus, the management team has developed a process to systematically document the potential missions' various requirements, such as technological components, technological prioritization, allocated timeframe, expected maturity level and costs. Furthermore, the AO released in June 2014 was based on experience acquired during a pilot project concluded in 2013–14.

*As noted in the Budgetary Financial Resources table, the variance of $4.4 million is mainly due to revised cash flow requirements stemming from delays in the issuance of contracts and contribution agreements.

Sub-Program 1.3.3: Qualifying and Testing Services

Description

This Sub-Program consists of specialized activities and services for the assembly, integration, and testing of space hardware and involves space qualifying technology, sub-units, units or entire spacecraft developed by Canadian academic institutions, Government of Canada (GoC) organizations, and industry, as well as international partners and clients. This Sub-Program is necessary to ensure that mission-assigned technology and entire systems can safely and reliably meet the rigours of space and to demonstrate the suitability and effectiveness of new Canadian space technology for providing valuable contributions to space missions. This provides an effective base for increasing Canada's capability to participate in future space programs.

This Sub-Program is delivered by the CSA's David Florida Laboratory on a fee-for-service basis.

Budgetary Financial Resources (dollars)

2014–15 Planned Spending	2014–15 Actual Spending	2014–15 Difference (actual minus planned)
6,111,175	4,811,635	(1,299,540)*

Human Resources (FTEs)

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
32.9	32.2	(0.7)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Test results of space hardware prove to be reliable in demonstrating suitability for launch and space environment.	1. Percentage of client satisfaction toward the quality of the services provided.	95% or higher.	99%

Performance Analysis and Lessons Learned

Overall, performance was outstanding based on the key indicator of client satisfaction, with the indicator target being exceeded by four percentage points. The survey results indicate a consistently high level of client satisfaction, with the David Florida Laboratory (DFL) achieving almost 100% client satisfaction.

This high level of satisfaction can be attributed to the fact that the DFL has continued to modernize its baseline services by implementing new program delivery technologies. These changes allow for increased efficiency, strengthened program integrity and seamless service delivery of programs and services, thus enabling the DFL to better respond to client expectations.

In February 2015, $13.5 million was approved over a three-year period for an infrastructure accelerated refit project. In line with the Economic Action Plan's Federal Infrastructure Initiative, these additional resources will contribute to the sustainability of the DFL and adequately manage issues associated with the reliability of testing stations.

In 2014–15, the DFL underwent an internal program evaluation while continuing to analyze various business models to ensure long-term sustainability. With respect to the program

evaluation, a number of recommendations were made to further improve performance. These included:

- The need to consult with stakeholders to provide guidance on current and future testing needs;
- The need to develop and put in place a more consistent and robust approach to measuring utilization which better reflects the DFL's overall operational philosophy;
- The need to undertake a study to identify realistic, potential markets for the DFL beyond the space sector in an attempt to improve overall utilization numbers; and
- The need for the CSA to review and revise the costing model for the DFL and to ensure that it is updated on a regular basis.

An action plan was adopted by CSA management, and the next report will describe the overall progress in meeting these recommendations.

*As noted in the Budgetary Financial Resources table, the variance of $1.2 million is mainly due to revised cash flow requirements and activity schedules and an internal reallocation for DFL infrastructure work.

To learn more about the Space Technology Development program (STDP), visit the CSA's STDP web page.[vii]

To learn more about a model of international cooperation with European Space Agency (ESA), visit the CSA's ESA web page.[viii]

To learn more about Stratospheric balloons (Stratos), visit the CSA's Stratospheric balloons web page.[ix]

Program 1.4: Internal Services

Description

Internal Services are groups of related activities and resources that are administered to support the needs of programs and other corporate obligations of an organization. These groups are Management and Oversight Services, Communications Services, Legal Services, Human Resources Management Services, Financial Management Services, Information Management Services, Information Technology Services, Real Property Services, Materiel Services, Acquisition Services, and Travel and Other Administrative Services. Internal Services include only those activities and resources that apply across an organization and not those provided to a specific program.

Budgetary Financial Resources (dollars)

2014–15 Main Estimates	2014–15 Planned Spending	2014–15 Total Authorities Available for Use	2014–15 Actual Spending (authorities used)	2014–15 Difference (actual minus planned)
46,179,765	46,179,765	47,519,454	45,245,854	(933,911)

Human Resources (Full-Time Equivalents [FTEs])

2014–15 Planned	2014–15 Actual	2014–15 Difference (actual minus planned)
262.0	235.2	(26.8)

Performance Results

Expected Results	Performance Indicators	Targets	Actual Results
1. Internal Services provide an added value to CSA managers in the performance of their duties.	1. The CSA's rating against MAF[9] criteria based on Round 2013–14 assessment.	Acceptable ratings are reached or maintained.	Acceptable compliance and ministerial comparison (MAF 2.0)

[9] MAF: Management Accountability Framework

Performance Analysis and Lessons Learned

In 2014–15, the CSA's renewed governance focused on a whole-of-government approach to space, uniting members from central agencies and federal departments and agencies involved in science-based activities. Interdepartmental space program integration boards at the assistant deputy minister and director general levels have been established to oversee the prioritization, sequencing, and program management of space asset development and utilization.

The CSA's first five-year Investment Plan was formally approved, highlighting the improvements in CSA management practices and adherence to government-wide policies. The Agency also considered lessons learned from the Management Accountability Framework assessments as well as from the results of the Public Service Employee Survey and internal audit recommendations in making management and oversight improvements.

To ensure sound policy and investment decisions and to identify key collaboration/partnership opportunities in support of industry, the Policy branch undertook a number of research initiatives to explore macro-economic and industrial issues, including a comprehensive socio-economic impact assessment of the Canadian space sector, spillover effects of CSA contracts, value-added services offered by the remote sensing industry, benefits and impacts of the RADARSAT missions, innovation in the Canadian space sector, and international trade barriers. Building on those studies, a comprehensive presentation has been developed to demonstrate how space has contributed to Canada's economic growth and job creation.

Approval of an Investment Governance and Monitoring Framework (IGMF), along with implementation of recommendations from internal audits on the Project Management Framework, led to the three following improvements: (1) development and implementation of accompanying tools and processes, more specifically reporting forms and procedures; (2) transfer and adaptation of project management tools and processes to "non-space" projects; and (3) implementation of formal and regular project reviews according to the IGMF.

As indicated in the Investment Plan, the CSA continued to implement its Policy on Internal Financial Controls.

Following the completion of the first implementation year of the 2013–16 Human Resources Integrated Plan, the CSA's results for the Management Accountability Framework component of "people management" are better than the average results for large departments and agencies in almost all areas. The same high level of performance was achieved in the area of values and ethics. The CSA's Public Service Employee Survey results were among the highest for large departments and agencies and have generally increased compared to 2011.

The Information and Technology Management division has successfully implemented a system that supports the secure exchange of information between the CSA and its partners. The system is compliant with the regulations set by Shared Services Canada and Treasury Board. Also in 2014–15, the CSA completed its first transfer of historical documents to Library and Archives Canada. This transfer will allow Canadians to trace back the history of the CSA's major projects and its relations with its partners.

The actions identified in Year 2 of the CSA's Departmental Security Plan were completed as planned. These actions respond to Treasury Board Policy on Government Security and the CSA's Emergency Management Plan, as required by the *Emergency Management Act*.

Implementation of a five-year evaluation plan as well as performance measurement strategies applicable to all programs was ongoing. Overall, there were four evaluations undertaken in 2014–15. One has been completed and six performance measurement strategies have been approved. The Audit Committee's annual report highlighted continuous improvement of the CSA's integrated monitoring of its response to audits and evaluations and third-party recommendations.

Section III: Supplementary Information

Financial Statements Highlights

The financial highlights presented below are intended to serve as a general overview of the Agency's financial position and operations. More detailed information is provided in the Agency's financial statements available online in the section on Departmental Performance Reports[x] (DPRs) which are prepared using an accrual accounting basis. Below are explanations for the variances in each major grouping based on the most significant factors that affected each grouping during 2014–15.

Condensed Statement of Operations (unaudited)
For the Year Ended March 31, 2015
(dollars)

Financial Information	2014–15 Planned Results	2014–15 Actual	2013–14 Actual	Difference (2014–15 actual minus 2014–15 planned)	Difference (2014–15 actual minus 2013–14 actual)
Total expenses	341,853,998	322,965,497	300,984,415	(18,888,501)	21,981,082
Total revenues	0	129,064	554,778	129,064	(425,714)
Net cost of operations before government funding and transfers	341,853,998	322,836,433	300,429,637	(19,017,565)	22,406,796

Total planned expenses for 2014–15 were $341.9 million, an overstatement of $18.9 million compared to actual results of $323 million. The variance between planned and actual expenses is mainly explained by the following:

- Less data (imagery) was purchased ($10.2 million) from RADARSAT-2 data credit than planned; and
- Amortization expenses as assets under construction, planned to be capitalized to tangible capital assets in 2014–15, were lower than projected ($7 million).

Total 2014–15 expenses added up to $323 million, a $22 million increase over the previous year's total expenses of $301 million. The increase is mainly explained by the following:

- In 2014–15, there was a $12.9 million difference in machinery acquisition and material expenses compared with 2013–14, even though the CSA purchased approximately the same quantity of RADARSAT-2 data (imagery) under the Space Data, Information and

Services Program. In 2013–14, the acquisition of machinery and material expense category received a significant credit of $12.4 million to reflect a multi-year (2011–14) retroactive price reduction adjustment on RADARSAT-2 images; and

- An $8.2 million increase over the previous year in the transfer payment category attributable to an increase in the Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology and an increase in contributions under the cooperation agreement between Canada and the European Space Agency.

The Agency's total revenues were $0.1 million in 2014–15 ($0.6 million in 2013–14), including generated revenues of $2.4 million, $2.3 million of which were earned on behalf of the GoC (non-respendable revenues for the Agency). Revenues remained stable, with the majority reported under the sale of goods and services provided by the David Florida Laboratory, i.e. sale of goods and services to private business or other GoC departments, and under other revenues (gain on foreign exchange).

Condensed Statement of Financial Position (unaudited)
As at March 31, 2015
(dollars)

Financial Information	2014–15	2013–14	Difference (2014–15 minus 2013–14)
Total net liabilities	124,123,391	102,127,337	21,996,054
Total net financial assets	95,304,637	78,079,190	17,225,447
Departmental net debt	28,818,754	24,048,147	(4,770,607)
Total non-financial assets	1,407,807,298	1,350,824,410	56,982,888
Departmental net financial position	1,378,988,544	1,326,776,263	52,212,281

Total net liabilities of $124.1 million are mostly made up of accounts payable and accrued liabilities representing $115.2 million (92.8%). These represent goods and services received at year-end but that have not been paid by the Agency. Some of the most significant liabilities recorded at year-end are for the International Space Station, under the Space Exploration Program, and for the RADARSAT Constellation Mission (RCM), under the Space Data, Information and Services Program (1.1).

The $22 million increase in net liabilities ($124.1 million for 2014–15 compared to $102.1 million for 2013–14) is mainly explained by a $21.9 million increase in accounts payable for RCM project invoices received at the end of 2014–15 but that were not paid.

Total assets were $1.5 billion at the end of 2014–15 ($95.3 million of net financial assets and $1.4 billion in non-financial assets), a $74.2 million (5.2%) increase compared with the previous year's total of $1.43 billion. The variance is mainly due to the increase in tangible capital assets.

Tangible capital assets of $1.2 billion represent 78.7% of total assets and are mainly composed of space-related assets ($1.12 billion).

Financial Statements

Financial Statements are available on the Canadian Space Agency's website.[xi]

Supplementary Information Tables

The supplementary information tables listed in the *2014–15 Departmental Performance Report* can be found on theCanadian Space Agency[xii]'s website.

- Details on Transfer Payment Programs;
- Status Report on Transformational and Major Crown Projects;
- Internal Audits and Evaluations;
- Response to Parliamentary Committees and External Audits;
- Status Report on Projects Operating With Specific Treasury Board Approval;
- User Fees Reporting; and
- Departmental Sustainable Development Strategy.

Tax Expenditures and Evaluations

The tax system can be used to achieve public policy objectives through the application of special measures such as low tax rates, exemptions, deductions, deferrals and credits. The Department of Finance Canada publishes cost estimates and projections for these measures annually in the Tax Expenditures and Evaluations[xiii] publication. The tax measures presented in the Tax Expenditures and Evaluations publication are the responsibility of the Minister of Finance.

Section IV: Organizational Contact Information

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Appendix: Definitions

appropriation (*crédit*): Any authority of Parliament to pay money out of the Consolidated Revenue Fund.

budgetary expenditures (*dépenses budgétaires*): Includes operating and capital expenditures; transfer payments to other levels of government, organizations or individuals; and payments to Crown corporations.

Departmental Performance Report (*rapport ministériel sur le rendement*): Reports on an appropriated organization's actual accomplishments against the plans, priorities and expected results set out in the corresponding Report on Plans and Priorities. These reports are tabled in Parliament in the fall.

full-time equivalent (*équivalent temps plein*): Is a measure of the extent to which an employee represents a full person-year charge against a departmental budget. Full-time equivalents are calculated as a ratio of assigned hours of work to scheduled hours of work. Scheduled hours of work are set out in collective agreements.

Government of Canada outcomes (*résultats du gouvernement du Canada*): A set of 16 high-level objectives defined for the government as a whole, grouped in four spending areas: economic affairs, social affairs, international affairs and government affairs.

Management, Resources and Results Structure (*Structure de la gestion, des ressources et des résultats*): A comprehensive framework that consists of an organization's inventory of programs, resources, results, performance indicators and governance information. Programs and results are depicted in their hierarchical relationship to each other and to the Strategic Outcome(s) to which they contribute. The Management, Resources and Results Structure is developed from the Program Alignment Architecture.

non-budgetary expenditures (*dépenses non budgétaires*): Includes net outlays and receipts related to loans, investments and advances, which change the composition of the financial assets of the Government of Canada.

performance (*rendement*): What an organization did with its resources to achieve its results, how well those results compare to what the organization intended to achieve and how well lessons learned have been identified.

performance indicator (*indicateur de rendement*): A qualitative or quantitative means of measuring an output or outcome, with the intention of gauging the performance of an organization, program, policy or initiative respecting expected results.

performance reporting (*production de rapports sur le rendement*): The process of communicating evidence-based performance information. Performance reporting supports decision making, accountability and transparency.

planned spending (*dépenses prévues*): For Reports on Plans and Priorities (RPPs) and Departmental Performance Reports (DPRs), planned spending refers to those amounts that receive Treasury Board approval by February 1. Therefore, planned spending may include amounts incremental to planned expenditures presented in the Main Estimates.

A department is expected to be aware of the authorities that it has sought and received. The determination of planned spending is a departmental responsibility, and departments must be able to defend the expenditure and accrual numbers presented in their RPPs and DPRs.

plans (*plan*): The articulation of strategic choices, which provides information on how an organization intends to achieve its priorities and associated results. Generally a plan will explain the logic behind the strategies chosen and tend to focus on actions that lead up to the expected result.

priorities (*priorité*): Plans or projects that an organization has chosen to focus and report on during the planning period. Priorities represent the things that are most important or what must be done first to support the achievement of the desired Strategic Outcome(s).

program (*programme*): A group of related resource inputs and activities that are managed to meet specific needs and to achieve intended results and that are treated as a budgetary unit.

Program Alignment Architecture (*architecture d'alignement des programmes*): A structured inventory of an organization's programs depicting the hierarchical relationship between programs and the Strategic Outcome(s) to which they contribute.

Report on Plans and Priorities (*rapport sur les plans et les priorités*): Provides information on the plans and expected performance of appropriated organizations over a three-year period. These reports are tabled in Parliament each spring.

results (*résultat*): An external consequence attributed, in part, to an organization, policy, program or initiative. Results are not within the control of a single organization, policy, program or initiative; instead they are within the area of the organization's influence.

statutory expenditures (*dépenses législatives*): Expenditures that Parliament has approved through legislation other than appropriation acts. The legislation sets out the purpose of the expenditures and the terms and conditions under which they may be made.

Strategic Outcome (*résultat stratégique*): A long-term and enduring benefit to Canadians that is linked to the organization's mandate, vision and core functions.

sunset program (*programme temporisé*): A time-limited program that does not have an ongoing funding and policy authority. When the program is set to expire, a decision must be made whether to continue the program. In the case of a renewal, the decision specifies the scope, funding level and duration.

target (*cible*): A measurable performance or success level that an organization, program or initiative plans to achieve within a specified time period. Targets can be either quantitative or qualitative.

voted expenditures (*dépenses votées*): Expenditures that Parliament approves annually through an Appropriation Act. The Vote wording becomes the governing conditions under which these expenditures may be made.

whole-of-government framework (*cadre pangouvernemental*): Maps the financial contributions of federal organizations receiving appropriations by aligning their Programs to a set of 16 government-wide, high-level outcome areas, grouped under four spending areas.

Endnotes

i **Whole-of-government framework**: http://www.tbs-sct.gc.ca/ppg-cpr/frame-cadre-eng.aspx

ii **Public Accounts of Canada 2015**: http://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/index-eng.html

iii **Public Works and Government Services Canada website**: http://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/index-eng.html

iv **Satellites**: http://www.asc-csa.gc.ca/eng/satellites/default.asp

v **Space Science and Exploration**: http://www.asc-csa.gc.ca/eng/activities.asp

vi **Evaluation of the STDP**: http://www.asc-csa.gc.ca/eng/publications/er-570-2800.asp

vii **Space Technology Development program**: http://www.asc-csa.gc.ca/eng/programs/stdp/default.asp

viii **Cooperation Agreement between Canada and the European Space Agency (ESA)**: http://www.asc-csa.gc.ca/eng/programs/esa/default.asp

ix **Stratospheric balloons**: http://www.asc-csa.gc.ca/eng/sciences/balloons/default.asp

x **Departmental Performance Reports**: http://www.asc-csa.gc.ca/eng/publications/rp.asp

xi **Financial Statements**: http://www.asc-csa.gc.ca/eng/publications/rp.asp

xii **Supplementary Information Tables**: http://www.asc-csa.gc.ca/eng/publications/rp.asp

xiii **Government of Canada Tax Expenditures**: http://www.fin.gc.ca/purl/taxexp-eng.asp